Nos. 2015-1789, 2015-1790

United States Court of Appeals for the Federal Circuit

CORE LABORATORIES LP,
APPELLANT

v.

SPECTRUM TRACER SERVICES, LLC,
APPELLEE

APPEALS FROM THE UNITED STATES PATENT AND TRADEMARK OFFICE,
PATENT TRIAL AND APPEAL BOARD
CASE NOS. 95/002,141 & 95/002,144
JUDGES CHUNG K. PAK, JEFFREY B. ROBERTSON, AND RAE LYNN P. GUEST

BRIEF FOR APPELLANT

J. DEAN LECHTENBERGER
Winston & Strawn LLP
1111 Louisiana Street
Houston, TX 77002
(713) 651-2600
jlechtenberger@winston.com

TANYA L. CHANEY
Shook, Hardy & Bacon, LLP
600 Travis Street, Ste. 3400
Houston, TX 77002
(713) 227-8008
tchaney@shb.com

STEFFEN N. JOHNSON
EIMERIC REIG-PLESSIS
CHRISTOPHER E. MILLS
Winston & Strawn LLP
1700 K Street, N.W.
Washington, DC 20006
(202) 282-5000
sjohnson@winston.com
ereigplessis@winston.com
cmills@winston.com

Counsel for Appellant

CERTIFICATE OF INTEREST

Counsel for Appellant Core Laboratories LP certifies the following:

1. **The full name of every party or amicus represented by me is:**

   Core Laboratories LP.

2. **The name of the real party in interest (if the party named in the caption is not the real party in interest) represented by me is:**

   N/A. The real parties in interest are the same as the parties represented.

3. **All parent corporations and any publicly held companies that own 10 percent or more of the stock of the party or amicus curiae represented by me are:**

   Core Laboratories LP is a limited partnership organized under the laws of Delaware and consisting of a limited partner, Core Laboratories Holding LLC, and a general Partner, Core Laboratories LLC, both of which are limited liability companies organized under the laws of Delaware. The parent company of both Core Laboratories Holding LLC and Core Laboratories LLC is Core Laboratories Holding Inc., a privately held corporation organized under the laws of Delaware, and whose parent company is Core Laboratories (U.S.) Interests Holdings, Inc., a privately held corporation organized under the laws of Texas. The parent company of Core Laboratories (U.S.) Interests Holdings, Inc. is Core Laboratories Luxembourg S.à.r.L, a privately held corporation organized under the laws of Luxembourg, and whose parent company is Core Laboratories (Gibraltar) Ltd., a privately held corporation organized under the laws of Gibraltar. The parent company of Core Laboratories (Gibraltar) Ltd. is CL International Trading N.V., a privately held corporation organized under the laws of Curaçao. The parent company of CL International Trading N.V. is Core Laboratories Sales N.V., a privately held corporation organized under the laws of Curaçao. The parent company of Core Laboratories Sales N.V. is Core Laboratories N.V., a publicly held corporation organized under the laws of The Netherlands. Core Laboratories N.V. is not owned by any parent corporation and no other publicly held corporation owns 10% or more of its stock.

4. The names of all law firms and the partners or associates that appeared for the party or amicus now represented by me in the trial court or agency or are expected to appear in this court are:

Winston & Strawn LLP: Steffen N. Johnson, J. Dean Lechtenberger, Eimeric Reig-Plessis, Christopher E. Mills

Shook, Hardy & Bacon, LLP: Tanya L. Chaney

Mossman, Kumar & Tyler, PC: Gene L. Tyler, Chandran Kumar

Dated: SEPTEMBER 30, 2015

/s/ Steffen N. Johnson
STEFFEN N. JOHNSON
Counsel for Appellant

TABLE OF CONTENTS

TABLE OF AUTHORITIES

Page(s)

CASES

STATUTES

GLOSSARY OF ABBREVIATIONS

’175 patent	U.S. Patent No. 6,659,175 B2
’662 patent	U.S. Patent No. 7,032,662 B2
Board	Patent Trial and Appeal Board
Core	Appellant-Patent Owner Core Laboratories LP
Core’s patents	The ’175 and ’662 patents
Deans	U.S. Patent No. US 4,090,398
Hall	European Patent Application 0 282 232 A2
Hampton	J. Thomas Hampton (a named inventor of Core’s patents)
Hinkel	U.S. Patent No. 6,192,985 B1
PTO	Patent and Trademark Office
Spectrum	Appellee-Requester Spectrum Tracer Services, LLC
Wooley	Dr. Gary Wooley (Core’s expert witness)

STATEMENT OF RELATED CASES

This *inter partes* reexamination appeal stems from a case pending in the District Court for the Western District of Oklahoma involving the same parties. *Core Laboratories LP v. Spectrum Tracer Servs., LLC, Steve Faurot, & Kelly Bryson*, No. 11-1157 (W.D. Okla.). Appellant Core Laboratories brought suit against two former employees and Appellee Spectrum Tracer Services, alleging misappropriation of trade secrets, unfair competition, breach of contract, copyright infringement, violation of Texas's Theft Liability Act, and later patent infringement.

Core initially sought a preliminary injunction, but the district court denied it. The court later held a *Markman* hearing in which it construed the claims of both of Core's patents at issue here, adopting Core's proposed constructions. Defendants then sought *inter partes* reexamination of both patents in the Patent and Trademark Office, and moved to stay the litigation. The court stayed litigation of the patent claims until the reexaminations were completed. Litigation of the other claims has since proceeded, and those claims are set for trial beginning November 3, 2015.

On the same day that the district court granted the stay, Core learned that Spectrum possessed some of Core's trade secret software. Core sought a preliminary injunction enjoining defendants from using that software, but the district court denied the motion. This Court reversed and remanded for the district court to enter a preliminary injunction prohibiting defendants from using Core's trade secrets.

INTRODUCTION

This appeal involves the technology of hydraulic fracturing—a unique and complex process for recovering oil and gas from unconventional reservoirs such as shales. Hydraulic fracturing requires injecting specialized fluids into rock formations at extreme pressures, breaking those formations and keeping the resulting fractures "propped" open so that hydrocarbons can flow up to the surface. Before that can happen, however, the spent fracturing fluid must be recovered in a "clean-up" procedure—otherwise, it could block or contaminate the production.

For decades, operators "cleaning up" a newly fractured well could not reliably determine *how much* fracturing fluid was left behind—causing expenses and production delays. To solve that problem, Core invented and patented a method of using "tracers" to measure the recovery of hydraulic fracturing fluids. Core's invention, which had never been tried, became enormously successful and garnered widespread industry praise.

Competitors including Spectrum quickly sought to copy Core's invention and partake in its commercial success. After Core sued Spectrum for infringement, Spectrum requested and obtained *inter partes* reexamination of Core's patents. Although nothing in the prior art taught or suggested Core's invention, a PTO examiner rejected Core's patent claims as obvious, and the Patent Trial and Appeal Board affirmed. Those rejections rest on three basic errors requiring reversal.

First, the PTO misconstrued the patent claims. As amended during reexamination, Core's claims are limited to hydraulic fracturing operations. That limitation is critical, because all agree that Core's tracer-calculation method had never been attempted in the unique setting of hydraulic fracturing. Yet even though the claims now explicitly require a material "useful for hydraulically fracturing the oil well" (A4), "[t]he Examiner determined that the claim [language] is not limited to a hydraulic fracturing operation" (A7-8).[1]

That "determination" cannot be reconciled with the patent specification or Core's *undisputed* testimony that "a person having ordinary skill in the art would understand that 'a material useful for hydraulically fracturing the oil well' would only be used for hydraulic fracturing, and, therefore, the amended claim[s] [are] limited to … hydraulic fracturing." A1605. Indeed, Spectrum itself admitted that the amended claims "are now limited to a method of hydraulic fracturing." A641. Spectrum changed its tune only when the examiner misconstrued Core's claims.

Second, the PTO's failure to construe the claims correctly led it to combine references that are "not analogous" to Core's invention, and thus are "not within the scope of the prior art … for purposes of the obviousness analysis." *Circuit*

[1] Unless otherwise noted, we cite only the record regarding one of Core's two patents, No. 6,659,175. The second, No. 7,032,662, is a continuation of the '175 patent, and its claims and specification are very similar. In all relevant respects, the PTO's findings as to both patents are identical.

Check Inc. v. QXQ Inc., 795 F.3d 1331, 1335 (Fed. Cir. 2015). Specifically, the PTO combined a reference on hydraulic fracturing with references on water-flooding and well-drilling—distinct and unrelated operations. The PTO deemed it appropriate to combine these references because each involves the "recovery of material injected into an oil well and … are operations that occur during oil and gas exploration and production." A10. But as this Court has held in reversing nearly identical PTO logic, a reference "cannot be considered" analogous to an invention "merely because both relate to the petroleum industry." *In re Clay*, 966 F.2d 656, 659 (Fed. Cir. 1992).

It is no answer to say that each reference involves the use of "tracers." As this Court recently reaffirmed, a reference outside an inventor's "field of endeavor" "can be analogous only if it is reasonably pertinent to the particular problem solved by the inventor." *QXQ*, 795 F.3d at 1335. Here, none of the cited "tracer studies" addresses the same or even a similar problem as Core's invention. In fact, the PTO's main reference on tracer calculations explicitly warns that "the injection rate should not be so high that the formation will fracture" (A299(7:42-43))—"guidance [that] actually teaches *away* from the Board's posited combination" of using tracers in hydraulic fracturing operations. *Leo Pharm. Prods., Ltd. v. Rea*, 726 F.3d 1346, 1355 (Fed. Cir. 2013).

Third, the PTO improperly disregarded objective indicia of nonobviousness. Core presented extensive proof that the commercial embodiment of its invention has been extremely successful commercially, with skyrocketing revenues, customer praise, and attempts by competitors to copy Core's service. The PTO disregarded this evidence, believing there was no "nexus" between the claims and Core's service. But in uncontroverted testimony, a former company president and named inventor of Core's patents provided "firsthand, personal knowledge" that Core's "tracing services practice every limitation of the amended claim[s]." A1016. Although Spectrum was co-founded by a former Core manager who likewise had personal knowledge of Core's practices, Spectrum offered no contrary evidence. Moreover, the PTO ignored the 20-year difference between the publication dates of its primary references and the date of Core's patent applications, which "speaks volumes to the nonobviousness" of Core's invention. *Leo*, 726 F.3d at 1359.

The rejections below should be reversed.

JURISDICTIONAL STATEMENT

The Board had jurisdiction under 35 U.S.C. §§ 6(b), 134(b), and 315(a), and entered its decision on March 24, 2015. Core timely noticed this appeal on May 22, 2015. The Board's decision is a final adjudication of all claims. This Court has jurisdiction under 35 U.S.C. §§ 141 and 319.

STATEMENT OF ISSUES

I. Whether the amended claims are limited to methods of hydraulic fracturing, where each claim requires either "a hydraulic fracturing fluid" or a material "useful for hydraulically fracturing the oil well";

II. Whether the PTO erred in finding the amended claims prima facie obvious over references regarding different fields of endeavor that are not reasonably pertinent to the particular problem addressed by the claimed invention; and

III. Whether the PTO erred in finding that objective indicia do not overcome any prima facie obviousness of the amended claims, where the success of Core's commercial product is directly attributable to practicing those claims.

STATEMENT OF THE CASE

On reexamination, the examiner rejected claims 1-7, 9, and 11 of the '175 patent, and claims 1-7, 9, 10, and 13-21 of the '662 patent, despite amendments by Core limiting the claims to hydraulic fracturing. A60-226. The Board affirmed. A1-59.

STATEMENT OF FACTS

A. Core's patents teach a method to determine the amount of hydraulic fracturing fluid recovered from a fractured well.

Core's patents concern hydraulic fracturing—a way of maximizing oil and gas production distinct from ordinary drilling. Because drilling oil wells "is expensive," "it is desirable to maximize both" "the overall recovery of hydrocarbon

held in the formation and the rate of flow from the subsurface formation to the surface." A288(1:23-29). "One way … to maximize production is the process known as fracturing," which "involves literally breaking or fracturing a portion of the hydrocarbon bearing formation surrounding an oil well by injecting a specialized fluid into the wellbore directed at the face of the geologic formation at pressures sufficient to initiate and/or extend a fracture." A288(1:30-36). This process creates a zone with "multiple fractures … through which hydrocarbon can more readily flow" to the surface. A288(1:37-40).

Creating such a fracture "requires several materials," which "if not removed … can interfere with oil and gas production." A288(1:42-44). Failing to remove these materials thoroughly, or "[t]aking too long" to remove them, "increase[s] the cost" and reduces "production rates." A288(1:47-50).

Before Core's invention, methods for removing fracturing materials were "usually inexact," making it difficult to estimate how much material had been recovered. A288(1:52-58). The claimed methods address this problem through "an inexpensive and environmentally benign method." A288(1:63). As amended during reexamination, Core's patents claim methods of using chemical tracers to determine the extent of recovery of hydraulic fracturing materials injected into an oil well. A288(1:13-19).

Before their amendment, the patents covered both drilling and fracturing, with one dependent claim limited to fracturing. A291, A1800. During reexamination, that claim's fracturing limitation was added to every independent claim. A450-53, A1827-31. Thus, every claim now requires that the material injected into the well be either "a hydraulic fracturing fluid" or "useful for hydraulically fracturing the oil well." A4, A32-33. Spectrum initially conceded that, as amended, "all of the remaining claims" are "limited to a method of hydraulic fracturing." A641, A1874.

Claim 1 of the '175 patent is representative, and claims:

> A method for determining the extent of recovery of materials injected into an oil well comprising the steps of:
>
> a) preparing a material to be injected into an oil well, ***wherein the material injected into the oil well is a material useful for hydraulically fracturing the oil well***;
>
> b) admixing therewith a chemical tracer compound at a predetermined concentration;
>
> c) injecting the admixture into an oil well;
>
> d) recovering from the oil well a production fluid;
>
> e) analyzing the production fluid for the concentration of the chemical tracer present in the production fluid; and
>
> f) calculating the amount of admixture recovered from the oil well using the concentration of the chemical tracer present in the production fluid as a basis for the calculation.

A4. The italicized language was added during reexamination.

The material useful for hydraulically fracturing the oil well contains various substances, including "a carrier fluid, a viscosifier, a proppant, and a breaker." A288(2:27-28). Once the material and tracer are admixed, the resulting fluid is injected into the well. A290(5:7-9). After this material has served its purpose, it is recovered from the well "along with reservoir fluids as a production fluid" and then "tested for tracer concentration." A290(5:17-25).

The final step is to use the tracer's concentration to calculate the amount of the admixture recovered from the well. If "the total amount of tracer admixed with the injected material is a known," as is "preferabl[e]," then "[t]he extent of recovery of materials injected" is determined "using a mass balance approach," which involves using a particular mathematical "formula." A290(5:28-43). "Where a mass balance approach is not possible or desirable, a relative rate of recovery can also be determined by measuring the concentration of tracer in the production fluids recovered from an oil well as a function of time." A290(5:44-47).

These six steps are included in each claim under reexamination. A291(7:36-8:57).[2] Claims 2-4 and 11 are directed to methods using specific types of tracers, claims 5-7 to methods using specific tracer concentrations, and claim 9 to a method using a specific calculation to determine the amount of admixture recovered. *Id*.

---

[2] The '662 patent's claims omit the "preparing" step. A1800-01.

B. The prior art does not teach or suggest using tracers to determine the amount of hydraulic fracturing fluids recovered.

In rejecting Core's independent claims as obvious, the PTO combined three prior art references.

Hinkel. First, U.S. Patent No. 6,192,985 B1 (Hinkel) "claims methods to enhance removal of spent fracturing fluid from a fracture deliberately created in the formation." A327(1:9-11). The goal of Hinkel was to remove "the fluid resident in the fracture tip … first rather than last," thereby increasing the effective fracture length. A329(5:61-63). "Tracers are not a primary purpose of" Hinkel, which mentions a tracer only in one example, "to confirm with a tracer study … that the first fluid injected returns first." A1566, A335(17:33-40).

Deans. Second, U.S. Patent 4,090,398 (Deans) "relates to a method for determining the fluid saturations of an immobile fluid phase and at least one mobile fluid phase in a subterranean reservoir." A296(1:16-19). Deans' goal is "to know the residual gas saturation in the portion of the formation flooded by water to estimate the recoverable gas in the unflooded portion." A296(1:46-49). As Core's expert, Dr. Gary Wooley, explained, this water-flooding operation involves a "relatively low pressure water injection into a reservoir to increase oil production"—unlike "hydraulic fracturing," which "injects fluid at high pressure not to cause flow through natural pore spaces of a conventional reservoir but to create fractures in an unconventional reservoir." A1567-68.

Indeed, Deans "specifically teaches away from hydraulic fracturing" (*id.* at A1568), warning that "the injection rate should not be so high that the formation will fracture" (A299(7:42-43)). Moreover, Deans expressly states that a "tracer … is not an essential feature of this invention." A299(7:17-18). "The principal purpose for using a tracer," if one is used at all, "is to aid in determining the fluid flow characteristics such as fluid drift and dispersion of the injected fluid." A298(6:18-21).

Hall. Third, European Patent Application 0 282 232 A2 (Hall) "relates to monitoring with tracers the circulation of drilling mud in a well during drilling." A338(1:1-3). Hall "is unrelated to production of oil and gas from reservoirs," and all of its applications "are related to drilling mud used to drill a well, before any production considerations, and particularly before any stimulation consideration such as hydraulic fracturing." A1569 (Wooley).

C. The examiner rejects the claims as obvious.

1. Prima facie obviousness

On reexamination, the examiner found that Core's amendment requiring that "the material injected into the oil well is a material useful for hydraulically fracturing the oil well" did not limit Core's claims to "a hydraulic[] fracturing method." A65. According to the examiner: "Materials useful as hydraulically fracturing fluids can also be useful for other purposes." A105. "For example," she announced,

"water is a material useful for hydraulically fracturing," making it "a hydraulically fracturing fluid" that is "useful for other purposes, such as drilling and waterflooding." *Id*.

Applying this construction, the examiner rejected the independent claims as obvious in view of two combinations of prior art. Claims 1, 5, and 6 were rejected as unpatentable over Hinkel in view of Deans. The examiner noted that Hinkel discloses "a fracture clean-up process which involves recovering the injected fluid from the fracture." A66. As the examiner recognized, "Hinkel does not specify that the *amount* of fracturing fluid recovered can be determined/calculated based upon the concentration of the tracer in the produced/recovered fluid." A67 (emphasis added). Nevertheless, she reasoned that one of Hinkel's examples suggests adding tracers at "various fracturing fluid stages in actual field applications so that a tracer study can be performed to verify the effectiveness of the fracture clean-up process." A66-67, A89.

Deans involves "use of tracers in a water flooding" operation. A91. And while Deans warns that "the injection rate should not be so high that the formation will fracture" (A93)—the defining purpose of hydraulic fracturing—the examiner found both references to be in the same field of endeavor as Core's patents. According to her, Core's patents do not state "that the inventive method only applies to a hydraulic fracturing process," but instead "state[] that the inventive method

can be used in a drilling, fracturing or any other operation requiring the injection of materials into an oil well." A90.

The examiner then found that, together, Hinkel and Deans rendered the independent claims obvious. "Deans teaches the use of tracer concentration profiles in the produced fluid for material balance purposes to determine/calculate the amount of injected fluid recovered," the examiner observed, and "discloses that the injected fluid can be an aqueous fluid." A67-68. Thus, she reasoned, "it would have been obvious" to a skilled artisan "to use the tracer concentration profiles in the produced/recovered fluid to calculate the amount of injected fluid recovered" per Deans "to determine the effectiveness of the fracture clean-up process" per Hinkel. A68.

The examiner also rejected Claims 1, 5-6, and 9 as unpatentable over Hinkel in view of Hall. While acknowledging that "Hinkel does not specify that the amount of fracturing fluid recovered can be determined/calculated based upon the concentration of the tracer," she considered Hall, which "teaches a method for monitoring drilling mud circulation in a well wherein a tracer is added to the aqueous drilling mud." A80. Notwithstanding this difference in context, the examiner found that Hall's "preferred operation involves injecting a quantity of tracer into the mud inlet at the surface," "detecting quantitatively the time variation of the tracer concentration as it returns to the surface," "processing the tracer return con-

centration data to obtain a residence time distribution for the circulation," "and using the time distribution to obtain information on the circulation." A81.

Moreover, according to the examiner, "[t]he tracer concentration curve generated from the operation can be used to measure fluid loss during circulation," and thereby "the amount of the injected fluid recovered," "by comparing the amount of the fluid injected into the well." A81. Thus, although Hall only "implicitly discloses that the amount of the fluid recovered from the well can be determined" (A97), the examiner found that it would have been obvious to "to use the tracer concentration in the produced/recovered fluid to calculate the amount of injected fluid recovered, as suggested by Hall, in order to determine the effectiveness of the fracture clean-up process disclosed in Hinkel" (A82).

The examiner then rejected the dependent claims in view of either Hinkel and Deans, or Hinkel and Hall, and other references. A82-88.

2. Objective indicia of nonobviousness

The examiner then rejected Core's showing of a nexus "between the elements" of the claims and "the commercial process" that Core's ProTechnics division uses, called Spectrachem®. A97. As she acknowledged, "the SPECTRACHEM® brochure states that SPECTRACHEM® is a patented chemical tracer technology"; that it "involves injecting tracers into different fracturing stages," followed by analysis of "flowback samples"; and "that the tracers are routinely used

to quantify and profile fracturing fluid clean-up and flowback efficiency over time." A97-98. Nevertheless, the examiner refused to find a nexus between this service and Core's patents, because "the brochure does not specify that the amount of the admixture of the tracer and the injected material recovered are calculated using the concentration of the tracer present in the production fluid as a basis as claimed." A98 (emphasis omitted). Moreover, she believed that "the brochure d[id] not provide any evidence of commercial success." *Id.*

The examiner also rejected Core's other proof that SpectraChem uses the claimed invention. Thomas Hampton—a named inventor and former president of Core's ProTechnics division—submitted flowback reports demonstrating that "[t]he flowback samples are analyzed for the concentration of the tracer present in the production fluid." A132. But the examiner insisted that those reports likewise did "not show that the amount of the admixture recovered is *calculated*." *Id.*

Hampton explained that ProTechnics performs the calculating "step by either using a mass balance approach or a relative rate of recovery approach." A132. As he detailed, "the example flowback report … showed the concentration of each tracer over time," which sometimes "was zero, indicating that there was no flowback." *Id.* Further, ProTechnics used "tracer concentrations … to determine the amounts of fluid that were flowing back." *Id.* Although Hampton's testimony was

uncontroverted, the examiner repeated that "[the] brochure and the flowback report do not show that the amount of the admixture recovered is *calculated*." *Id*.

While acknowledging Hampton's declaration that a significant "number of jobs [are] performed using the invention of [the] Amended Claims," generating "a large amount of revenues," the examiner found that this was insufficient "*evidence* to show that the services provided by [Core] correspond to the claimed process." A101 (quotations omitted). In her view, Hampton's declaration was "*no* evidence that the … process which has been sold corresponds to the claimed invention." *Id*.

The examiner also believed that Core had "fail[ed] to show that any commercial success of the services [was] due to … the claimed process." A102. Such success, she speculated, could have been "the result of heavy promotion or advertising, shift in advertising, consumption by purchasers normally tied to applicant or assignee, or other business events extraneous to the merits of the claimed invention." *Id.* Yet Core "provide[d] evidence … that [its] marketing costs are less than 0.1% of revenues," and Spectrachem's purchasers are "companies that are not related to or affiliated with" it. A133. Again, the examiner rejected all "affidavit or declaration" testimony, and thus found "no evidence … that whatever commercial success may have occurred is attributable to the [claimed process]." *Id.* Finally, she rejected Hampton's sales figures as "insufficient" because they did not discuss "market share" or "what sales would normally be expected." A102-03.

Thus, the examiner found that Core's "evidence of secondary considerations" was "insufficient to overcome the obviousness rejections." A103.

D. The Board affirms the examiner's rejections.

The Board affirmed, holding that the claims are invalid as obvious in view of the combination of Hinkel and Deans.

Claim construction. The Board did not expressly decide whether the language added to the claims during reexamination limits the claims to hydraulic fracturing operations. According to the Board, "[e]ven assuming that … [the] claim[s] [are] limited to hydraulic fracturing," the claimed methods still would have been obvious. A8.

Combining Hinkel and Deans. Like the examiner, the Board held that Hinkel discloses "an admixture of a hydraulic fracturing fluid and a tracer used in a hydraulic fracturing operation." *Id.* The Board further found that a skilled artisan would have looked to the tracer study in Deans—even though it covers a method for determining fluid saturations in water reservoirs—to add the remaining steps of Core's claimed method: "(e) analyzing the production fluid for the concentration of the chemical tracer and (f) calculating the amount of admixture recovered." *Id*.

In holding that a skilled artisan would have combined Hinkel and Deans, the Board found that Deans' water-reservoir method was analogous to Core's methods. The Board was "not persuaded that the field of endeavor of [Core's patents] is lim-

ited to hydraulic fracturing," "but rather is related to any operation in which materials injected into an oil well during oil and gas exploration and production are recovered." A9-10. And "[b]oth water flooding and hydraulic fracturing operations require recovery of material injected into an oil well." A10.

The Board further reasoned that, even if the patents were limited to hydraulic fracturing, "both Hinkel and Deans are reasonably pertinent to the problem with which the inventor was concerned." *Id*. Hinkel "relates to recovery of fracturing material in a hydraulic fracturing process and using tracer studies to evaluate the effectiveness of the recovery." *Id*. The Board found Deans "reasonably pertinent since it teaches a method to determine the extent of recovery of a fluid injected into an oil well, *i.e.*[,] the volume of fluid injected into the formation that has been produced, using recovered tracer concentrations." A11.

Having held that Hinkel and Deans were analogous, the Board next found that "it would have been obvious to a skilled artisan to use the recovery evaluation procedure of Deans to determine the full extent of recovery of the hydraulic fracturing fluid in the hydraulic fracturing operation of Hinkel." *Id.* While acknowledging that "the diagnostics discussed in Hinkel are directed to the improvement in removing fluid retained in the distal-most portion of the fracture," the Board concluded that "Hinkel nonetheless teaches the importance of ensuring maximum re-

covery of injected hydraulic fracturing material" and thus "provides sufficient reason for the skilled artisan to evaluate the extent of admixture recovered." A12.

Moreover, although Deans expressly teaches "that the injection rate should not be so high that the formation will fracture," the Board concluded that Deans does not teach away from Core's claimed method, because nothing would discourage a skilled artisan "from applying the tracer study of Deans … to the fracturing process of Hinkel." A13 & n.12.

Objective indicia of nonobviousness. As to objective indicia, the Board refused to consider whether "ProTechnics' SpectraChem service satisfied a long felt but unmet need in the art, was copied, received industry praise, [or] was commercially successful." A14. The Board rejected Core's evidence of these objective indicia, instead affirming the Examiner's determination "that there was insufficient evidence to find a nexus between the SpectraChem service offered by ProTechnics and the claimed method for the evidence to hav[e] meaningful weight in an obviousness analysis." A14. In particular, the Board questioned "whether the SpectraChem service meets the requirements of the claimed invention, particularly the 'calculating step.'" A17. While acknowledging that "Hampton, as president of the ProTechnics division of Core Laboratories, would have personal knowledge of [its] services," the Board "decline[d] to give substantial weight to [his] testimony" "that

'the tracer concentrations were used to determine the amounts of fluid that were flowing back.'" A16.

Instead, the Board insisted on additional "corroborating evidence"—and then rejected the evidence that Core provided. A16-17. Although the Spectra-Chem brochure stated that ProTechnics performs the calculating step "by either using a mass balance approach or a relative rate of recovery," the Board held that the brochure lacked "sufficient specificity." A15, A17. The Board thus found Core's evidence of objective indicia irrelevant, and claims 1, 5, and 6 unpatentable over Hinkel and Deans. The Board also found the dependent claims unpatentable. A21-26. Because these findings were deemed dispositive of all claims, the Board did not reach the examiner's "obviousness rejections based on other references," including her rejection of the independent claims over Hinkel and Hall. A26.

SUMMARY OF ARGUMENT

As amended during reexamination, Core's claims are patentable over the prior art. The PTO could conclude otherwise only by making multiple errors.

I. First, the PTO misconstrued the amended claims. Each claim calls for either "a hydraulic fracturing fluid" or a material "useful for hydraulically fracturing." A4, A32-33. Thus, as Spectrum conceded, the claims "are now limited to a method of hydraulic fracturing." A641. Yet the examiner "determined that the

claim[s] [are] not limited to a hydraulic fracturing operation"—a finding the Board erroneously left intact. A7-A8.

I.A. Although claims on reexamination are given their "broadest reasonable interpretation," the PTO may not "construe claims … so broadly that its constructions are *unreasonable* under general claim construction principles." *Microsoft Corp. v. Proxyconn, Inc.*, 789 F.3d 1292, 1298 (Fed. Cir. 2015). "Rather, claims should always be read in light of the specification" as viewed by "those skilled in the art." *Id.* (quotation omitted).

I.B-C. Here, the PTO ignored both the understanding of a skilled artisan and the specification. As Core's unchallenged expert testimony showed, a skilled artisan "would understand that 'a material useful for hydraulically fracturing the oil well' would only be used for hydraulic fracturing." A1605 (Wooley). Moreover, the specification teaches that "[h]ydraulic fracturing involves … a specialized fluid" and does *not* involve any drilling. A288(1:31-36).

Nevertheless, the examiner held that Core's amendments "do not limit the injected material to be used only for hydraulic fracturing," reasoning that "water is a material useful for hydraulically fracturing," yet also "useful for other purposes." A105. But nothing in Core's patents or the prior art suggests that plain water is useful for hydraulic fracturing. Rather, while "the *first* fracturing *component*"—the "carrier fluid"—may be "aqueous-*based*," it must be "prepared" to change

"viscosity"—first to "prop" open a fracture, then to "break[]" out of it. A288-89(2:34-3:5) (emphasis added). Only "specialized" fluids can do that.

II.A. The PTO's overbroad "construction of the disputed claim term" led directly to its second mistake—its "determination that [Deans and Hall] are analogous art." *In re Bigio*, 381 F.3d 1320, 1324 (Fed. Cir. 2004). "[T]o rely on [a] reference as a basis for rejection," the "analogous-art test requires that the Board show that [the] reference is either in the field of the applicant's endeavor or is reasonably pertinent to the problem with which the inventor was concerned." *In re Kahn*, 441 F.3d 977, 987 (Fed. Cir. 2006). The PTO made neither showing.

First, neither Deans nor Hall relates to Core's field of endeavor, which is limited to determining the extent of recovery of hydraulic fracturing fluids in a hydraulic fracturing operation. Indeed, the undisputed definition of an ordinarily skilled artisan here confirms that such an artisan is experienced with the "technology of using tracers in *hydraulic fracturing*." A1584 (emphasis added), A1563.

Deans and Hall concern wholly dissimilar fields—water flooding and drilling. A296(1:33-49), A338(1:1-8). Unlike "hydraulic fracturing"—which is "a means to increase recovery from … unconventional reservoirs" such as "shales"—"water flooding" is a "secondary" stage of "[r]ecovery of oil from conventional reservoirs such as sands." A1567-68 (Wooley). Further, fracturing does not in-

volve "drilling," which occurs "before any production considerations, and particularly before any stimulation consideration such as hydraulic fracturing." A1569.

In treating such endeavors as interchangeable because they "require recovery of material injected into an oil well and … occur during oil and gas exploration and production" (A10), the PTO violated this Court's holding that teachings "cannot be considered to be within [the same] field of endeavor merely because [they] relate to the petroleum industry." *Clay*, 966 F.2d at 659. That was reversible error. *Id*.

Second, while Deans and Hall discuss tracer studies that address *other* problems, they are not reasonably pertinent to the problem solved by Core—the need "to determine *how much* [fracturing fluid] is left in an oil well." A288(1:57-61) (emphasis added). In Deans, the "purpose for using a tracer is to aid in determining the fluid flow characteristics such as fluid drift and dispersion"—not determining how much fluid is left, let alone in fracturing operations. A298(6:17-20). Hall uses tracers for yet another purpose—timing how long it takes "drilling mud to travel from the surface down the hole … and up to the surface again." A338(1:4-8). Because Deans and Hall are "not reasonably pertinent to the particular problem with which [Core's inventors] w[ere] involved," "[t]he [PTO]'s finding" that they are analogous was "erroneous," and requires reversal. *Clay*, 966 F.2d at 659-60.

II.B. Even if Deans and Hall were analogous art, combining them with Hinkel would not have been obvious—for three independent reasons.

First, Deans teaches *away* from hydraulic fracturing by expressly warning that "the injection rate should not be so high that the formation will fracture." A299(7:42-43). Because that "teaching[] undermine[s] the very reason being proffered as to why a person of ordinary skill would have combined" Deans with Hinkel, "[a]n inference of nonobviousness is especially strong." *DePuy Spine, Inc. v. Medtronic Sofamor Danek, Inc.*, 567 F.3d 1314, 1326 (Fed. Cir. 2009).

Aware of that difficulty, the Board declared that "any difference in the injection rate" in Deans "does not amount to a teaching away from applying [its] tracer study … to the fracturing process of Hinkel." A13. Yet the Board was not free to rely on discrete passages of Deans while ignoring others. References must be read as a whole. By "considering the reference[] in less than [its] entiret[y]" and "disregarding disclosures … [that] teach away," the PTO "erred." *W.L. Gore & Assocs., Inc. v. Garlock, Inc.*, 721 F.2d 1540, 1550 (Fed. Cir. 1983).

Second, a skilled artisan would not have been motivated to combine Hinkel with either Deans or Hall, because their tracer studies are incompatible. Hinkel mentions tracers only in passing, and only for the limited purpose of "verify[ing]" whether "the first fluid injected [into the well] flows back sooner" than the rest. A335(17:33-40). Neither Deans nor Hall, however, is "described as being capable of making a distinction as to which fluid from a particular region in a fracture is the first to be recovered." A1609, A1613 (Wooley). Because modifying Hinkel's

tracer study with Deans or Hall "would require … a change in the basic principles under which [it] was designed to operate," their "combination … is not a proper ground for rejection." *In re Ratti*, 270 F.2d 810, 813 (C.C.P.A. 1959).

Third, even if a skilled artisan were "motivat[ed] to combine elements from [these] different prior art references," she would not "have perceived a reasonable expectation of success in making [Core's] invention via that combination." *Medichem, S.A. v. Rolabo, S.L.*, 437 F.3d 1157, 1165 (Fed. Cir. 2006).

"Hydraulic fracturing, water flooding, fluid flow studies, and drilling are each very different processes," and "[a] tracer study that is effective" in one "is not necessarily going to be effective" in another. A1615 (Wooley). Rather, to adapt a tracer study in one reference to the operation of another, a skilled artisan would need to alter "the types of injected material, the amount of injected material, the tracer concentration, the rate of injection, the fluid pressure in the injected material, the length of time the tracer spends in the formation, and the rate of production, among other things." A1613, A1615. Because "the prior art g[ives] … no indication of which parameters were critical [and] no direction as to which of many possible choices is likely to be successful," it "fails to provide the requisite 'reasonable expectation' of success" for "an obviousness determination." *Medichem*, 437 F.3d at 1165.

III.A. Even apart from the PTO's failure to establish a prima facie case, the agency's obviousness rejections cannot stand. Because objective indicia "'can be the most probative evidence of nonobviousness,'" and "are crucial in avoiding the trap of hindsight," "consideration of the objective indicia is *part of* the whole obviousness analysis." *Leo*, 726 F.3d at 1357-58. Here, however, the PTO refused to give the objective indicia—including the long-felt need for Core's services, their commercial success, and industry praise and adoption—any weight at all.

According to the PTO, Core did not tie its commercial services to the patent claims—specifically, the step of calculating the amount of admixture recovered. A21. But Core presented uncontroverted testimony from people with firsthand knowledge that its "tracing services practice every limitation of the amended claim," even "provid[ing] a claim chart that explained how ProTechnics' Spectra-Chem tracing services practice every limitation." A1017. Indeed, although Spectrum's president is a former Core manager who testified that he had "intimate familiarity" with Core's patented methods (A1596(105:9-20)), Spectrum never disputed Core's testimony "that the tracer concentrations were used to determine the amounts of fluid that were flowing back." A1018. Further, Core provided a sample client report "demonstrat[ing] that [its service] analyzes the samples for the concentration of the tracer fluid," and a commercial brochure stating that its ser-

vice "quantif[ies] and profile[s] frac fluid clean-up." *Id*. Thus, it was error for the Board to find no "nexus" between the claims and Core's services.

III.B. Beyond the economic indicia, the PTO ignored the extensive intervening time between the prior art and Core's invention in 2001. Where there is a long "intervening time between the publication dates of the prior art and the claimed invention," that "speaks volumes to the nonobviousness of the [invention]." *Leo*, 726 F.3d at 1359. Here, Deans issued in 1978. Hinkel was filed in 1998, but its relevant teaching—"the importance of ensuring maximum recovery of injected hydraulic fracturing material" (A41)—has been known ever since hydraulic fracturing was invented. A482. The fact that the relevant prior art teachings had been well-known for decades confirms that Core's invention was not obvious. The PTO should have relied on that objective evidence, "as opposed to [a] hindsight lens." *Leo*, 726 F.3d at 1359.

The decisions below should be reversed.

STANDARD OF REVIEW

This Court "review[s] the Board's factual findings for substantial evidence and its legal conclusions de novo." *Rambus Inc. v. Rea*, 731 F.3d 1248, 1251 (Fed. Cir. 2013). "Claim construction by the PTO is a question of law," "review[ed] de novo." *Id*. at 1252 (quotation omitted). Similarly, while "based on underlying fac-

tual determinations," "[w]hether a claim would have been obvious under 35 U.S.C. § 103(a) is a legal conclusion." *Id*. at 1251-52.

As to factual findings, "'substantial evidence' review involves examination of the record as a whole, taking into account evidence that both justifies and detracts from [the PTO's] decision." *In re Gartside*, 203 F.3d 1305, 1312 (Fed. Cir. 2000). "Substantial evidence is more than a mere scintilla;" it is "such relevant evidence as a reasonable mind might accept as adequate to support a conclusion." *Id*. (quotation omitted).

ARGUMENT

I. The amended claims are limited to hydraulic fracturing operations.

As amended during reexamination, every claim of Core's patents requires either "a hydraulic fracturing fluid" or a material "useful for hydraulically fracturing the oil well." A4, A32-33. That limitation initially appeared in dependent claim 8 of each patent, which Spectrum admitted "only pertain[ed] to … fracturing operations." A1415. Likewise, when Core canceled claim 8 and incorporated that limitation into each independent claim on reexamination, Spectrum conceded that "all of the remaining claims … are now limited to a method of hydraulic fracturing." A641, A1874. That should have been the end of the matter.

Despite the plain meaning of Core's amendments, however, "[t]he Examiner determined that the claim [language] is not limited to a hydraulic fracturing opera-

tion." A7-8, A37. That finding was legally flawed, and the Board's failure to reverse it was error.

A. Claim language must be construed consistently with the specification and understanding of a skilled artisan.

"In reexamination, claims are to be given their broadest reasonable interpretation consistent with the specification, and claim language should be read in light of the specification as it would be interpreted by one of ordinary skill in the art." *In re NTP, Inc.*, 654 F.3d 1279, 1287 (Fed. Cir. 2011) (quotation and alterations omitted). This inquiry "begin[s] with the claim language." *Id.* at 1288.

Importantly, "[t]he protocol of giving claims their broadest reasonable interpretation" in PTO proceedings "is solely an examination expedient, not a rule of claim construction"—and "does not include giving claims a legally incorrect interpretation." *In re Skvorecz*, 580 F.3d 1262, 1267 (Fed. Cir. 2009). Thus, the PTO may not "construe claims … so broadly that its constructions are *unreasonable* under general claim construction principles." *Microsoft*, 789 F.3d at 1298.

"Rather, claims should always be read in light of the specification and teachings in the underlying patent," and "the Board's construction … must be consistent with the one that those skilled in the art would reach." *Id.* (quotation omitted). "A construction that is unreasonably broad and which does not reasonably reflect the plain language and disclosure will not pass muster." *Id*. (quotation omitted). As discussed below, that is the problem here.

B. Unrebutted testimony, the specification, and prior art confirm the plain meaning of the claims as limited to hydraulic fracturing.

The claim language and overwhelming undisputed evidence confirm what Spectrum earlier admitted: Core's amendments—which require either "a hydraulic fracturing fluid" or a material "useful for hydraulically fracturing the oil well" (A4, A32-33)—limit the challenged claims to hydraulic fracturing operations.

1. As Dr. Wooley testified without contradiction, a skilled artisan "would understand that 'a material useful for hydraulically fracturing the oil well' would only be used for hydraulic fracturing, and, therefore, the amended claim[s] [are] limited to … method[s] of hydraulic fracturing." A1605. That testimony was echoed by Hampton—a named inventor—who confirmed that "materials useful for hydraulic fracturing an oil well are only used for hydraulic fracturing processes." A1014. Spectrum's expert, Dr. Jennings, never challenged this testimony.

Nor could he. As Wooley showed, the fact "that hydraulic fracturing materials are only used for hydraulic fracturing operations" is "demonstrat[ed]" by "[t]he specification." A1605. Indeed, because Core's original claims applied to operations other than hydraulic fracturing, the specification describes both the presently claimed embodiment of recovering hydraulic fracturing materials and the now-surrendered embodiment of recovering drilling materials. As the specification confirms, however, these operations use mutually exclusive materials.

For example, "[t]he practice of the present invention" involves "preparing the fracture materials *or* drilling fluids"—different fluids. A289(3:29-32) (emphasis added). Moreover, the "Background of the Invention" states that "[h]ydraulic fracturing involves … injecting a *specialized fluid* into the wellbore" designed "to initiate and/or extend a fracture in the formation." A288(1:31-36) (emphasis added). Similarly, "[a] drilling fluid is … *specially designed* to be circulated through a wellbore as the wellbore is being drilled." A289(3:8-10) (emphasis added). By definition, fluids that are "specialized" or "specially designed" for particular purposes are not interchangeable with others.

2. That is powerfully confirmed by the specification's descriptions of the compositions and functions of these fluids. For the first (and now exclusively claimed) "embodiment, the present invention is a method for determining the amount of fracture materials recovered after the stimulation of an oil well by means of hydraulic fracturing." A288(2:24-27). "Creating a fracture … requires several materials"—"includ[ing] a carrier fluid, a viscosifier, a proppant, and a breaker." A288(2:27-29). "The purpose of the first fracturing component"—the carrier fluid—"is to first create/extend a fracture in an oil and gas producing formation and then, once it is opened enough, to deliver proppant." A288(2:34-36).

"Most relevant to the present invention," however, is "the final component of the fracture fluid"—"the breaker"—which "lower[s] the viscosity of the fluid so

that it is more easily removed" after the proppant is delivered. A288-89(2:66-3:5). As inventor Hampton explained, "[f]racture stimulation fluids are designed to be viscous enough to carry proppants … into the formation being stimulated and then 'break' to a less viscous state and flow out of the formation leaving the proppant behind to 'prop' the created fractures open." A1016.

It is undisputed that this "requirement that fracture stimulation fluids should 'break' and then flow out of the formation is incompatible with the function performed by drilling fluids." A1016. Drilling fluids "are designed to be viscous enough to carry drill cuttings away from the drill bit and out of the hole being drilled," and "must always maintain [that] uniform weight and viscosity throughout the drilling operation in order to properly control the formation pressure, prevent formation fluids from entering the newly-drilled hole, and stabilize the formation." A1015-16. Accordingly, a skilled artisan "would understand that materials useful for hydraulically fracturing the oil well, such as those materials described at column 2" of the specification, "are not used during drilling"—"only … during hydraulic fracturing." A1606 (Wooley). Indeed, the "fracturing materials" disclosed in the patents "are incompatible with drilling operations," which "are specifically engineered to perform different functions." *Id.*

The patents illustrate those dissimilar functions in discussing the "[]other aspect" of "the present invention," which Core surrendered: "a method for determin-

ing the amount of drilling fluid recovered after the completion of an oil well." A289(3:6-8). As the patents explain, "[t]he drilling fluid performs a number of functions" that include "cooling and lubricating the drill bit, removing drill bit cuttings from the wellbore," and "maintain[ing] the integrity of the wellbore walls [to] prevent well blowouts." A289(3:14-20).

None of those functions, however, is performed by hydraulic fracturing materials, which "do not carry drill cuttings up inside the wellbore but instead carry proppant particles down the well." A1606-07 (Wooley). "There is no drill bit in the well when hydraulic fracture fluids are pumped, so there is no cooling of a drill bit" by fracturing fluids. A1607. Most significantly, "[d]rilling mud is intentionally designed not to fracture formations, … which could lead to well control problems and possibly a blowout." A1606. "In contrast, hydraulic fracture fluids are pumped through a well into formations *after drilling operations are finished*, and hydraulic fracture fluids are intentionally designed to fracture formations"—"just the opposite purpose of drilling muds." *Id*. (emphasis added). Stated simply: "Drilling muds would not be an acceptable hydraulic fracture fluid, and hydraulic fracture fluid would not make an acceptable drilling mud." A1607.

3. Indeed, "[t]he prior art" itself "demonstrate[s] that a person of ordinary skill in the art would understand that hydraulic fracturing fluids are only used for hydraulic fracturing." *Id*. Hinkel, for example, teaches that "[h]ydraulic frac-

turing involves … injecting a *specialized fluid* into the wellbore." A327(1:50-54) (emphasis added). Hinkel also explains that "creating a fracture in a hydrocarbon-bearing formation requires a *complex suite of materials*," and that "four *crucial components* are usually required: a carrier fluid or proppant-carrying matrix, a viscosifier, a proppant, and a breaker." A328(3:40-44) (emphasis added). Hinkel defines "fracturing fluid" as "the fluid used to deliver the proppant as well as … to create the fracture." A327(2:46-48); A328(3:47-51). Again, "[b]oth of these purposes are unique to hydraulic fracturing operations." A1607-08 (Wooley).

In short, Core's undisputed testimony, the specification, and even the prior art confirm that "hydraulic fracturing fluids are specialized," and that a skilled artisan "would not use them for any other type of application." A1608. Thus, the ordinary meaning of "a material useful for hydraulically fracturing" limits the amended claims to hydraulic fracturing operations. In "ignor[ing] the claim language and evidence of the understanding of a person of ordinary skill in the art," the PTO misconstrued that claim term. *NTP*, 654 F.3d at 1288.

C. The PTO's reasoning for broadening the claims beyond their plain meaning in light of the specification is unsupportable.

Neither the PTO nor Spectrum offered evidence to rebut Core's evidence. In fact, the examiner acknowledged that "[t]he recitation that 'the material injected into the oil well is a material useful for hydraulically fracturing the oil well' describes the intended use of the injected material … for hydraulically fracturing the

oil well." A104. Likewise, the examiner recognized that Wooley and Hampton each "discuss[ed] the difference between hydraulic fracturing fluids and drilling fluids and state[d] that hydraulic fracturing fluids are only used for hydraulic fracturing and drilling fluids are only for drilling." A104-05. Nevertheless, the examiner announced that "the claims do not limit the injected material to be used only for hydraulic fracturing" because "[m]aterials useful as hydraulic fracturing fluids can also be useful for other purposes." A105.

The examiner's only "example," however, was that "water is a material useful for hydraulically fracturing, *e.g.*, useful as a carrier fluid." *Id*. In support, the examiner described Core's patents as "disclos[ing] the use of water as a hydraulic fracturing fluid" in their sole "Example." *Id.* And because "water can also be useful for other processes, such as drilling and waterflooding," the examiner concluded that the amended claims "do[] not further limit the claimed method to be a hydraulically fracturing method." *Id.* The examiner was mistaken.

Nothing in the record suggests that "*water* is a material useful for hydraulically fracturing [an] oil well." Rather, the specification teaches that "[h]ydraulic fracturing involves … a specialized fluid"—which, by definition, cannot be water. A288(1:31-36). At most, "substances [that] can act as a suitable *carrier fluid* … are generally aqueous-*based* solutions." A288(2:41-42) (emphasis added). Further, "the carrier fluid" must be adequately "prepared"—"often … by blending a

polymeric gelling agent with [the] aqueous solution." A288(2:43-45). Yet water is not simply "aqueous-*based*"—it is aqueous throughout. And water requires no "prepar[ation]," never mind "blending" with other "agents."[3]

Even if the carrier fluid could be pure water, the "carrier fluid" is only the "*first* fracturing component"—and "[c]reating a fracture … requires *several* materials." A288(2:27-34) (emphasis added). And in all events, the carrier fluid "component" is not what distinguishes hydraulic fracturing materials from other materials. Rather, "[t]he carrier fluid is simply the means by which the proppant and breaker are carried into the formation." A288(2:38-40). It is "[t]he carrier fluid *together with proppant material* [that] is injected" into the oil well—not the carrier fluid alone. A288(2:37-38) (emphasis added).

Moreover, "[t]he purpose" of other additives "is to thicken the aqueous solution so proppant can be suspended in the solution for delivery into the fracture." A288(2:48-51). These agents "increas[e] the viscosity of the aqueous solution by 10 to 100 times, or even more." A288(2:52-54). Just as importantly, the "breaker" component—the component "[m]ost relevant to the present invention"—later reverses that thickening effect "so that [the fluid] is more easily removed from the fracture." A288-89(2:66-3:5). These critical functions of fracturing fluids—which

[3] The first step of the '175 patent's independent claims explicitly requires "preparing" the "material useful for hydraulically fracturing the oil well." A4.

uniquely *change* viscosity—cannot be performed with only water. Thus, the examiner's conclusion is logically flawed—at several levels.

The specification's example is not to the contrary. While it mentions water as an ingredient, it focuses on the specialized components—including "a high temperature oxidizing gel breaker," "gelling agent," and "proppant," to name a few—which are merely "*prepared … in* water." A290-91(6:63-7:16) (emphasis added). Thus, while "drilling and hydraulic fracturing[] require similar *base* fluids"—like water—they "are modified to behave very differently and perform different functions." A1015 (Hampton) (emphasis added).

It is no answer to say that both fracturing fluid and drilling fluid are *mostly* water. Practically any fluid is either water- or oil-based. It is not the base that defines what a fluid is "useful for," but its active materials and their concentrations—no matter how small. *E.g.*, *In re Brimonidine Patent Litig.*, 643 F.3d 1366, 1371 (Fed. Cir. 2011) ("a contact lens soak" is a "concentration of 0.005% to 2.0% SCD in water").

In the end, however, whether "a material useful for hydraulically fracturing the well" could conceivably be water does not matter. "Where the specification makes clear that the invention does not include a particular feature, that feature is deemed to be outside the reach of the claims of the patent, even though the language of the claims, read without reference to the specification, might be consid-

ered broad enough to encompass the feature." *SciMed Life Sys., Inc. v. Advanced Cardiovascular Sys., Inc.*, 242 F.3d 1337, 1341 (Fed. Cir. 2001). Because the examiner's construction—undisturbed by the Board—"is inconsistent with the broadest reasonable interpretation in view of the specification," the PTO "erred." *In re Imes*, 778 F.3d 1250, 1252 (Fed. Cir. 2015).

II. The amended claims are patentable over the prior art.

Once it becomes clear that Core's amended claims are limited to hydraulic fracturing, it becomes equally clear that the rejections below must be reversed. To reject Core's independent claims, the Board combined elements from Hinkel and Deans, and the examiner additionally combined Hinkel and Hall. Yet neither Deans nor Hall is analogous prior art. And even if they were analogous, it would not have been obvious for a skilled artisan to combine them with Hinkel.

A. The PTO erroneously relied on non-analogous art.

"[T]o rely on [a] reference as a basis for rejection," "[t]he analogous-art test requires that the Board show that [the] reference is either in the field of the applicant's endeavor or is reasonably pertinent to the problem with which the inventor was concerned." *Kahn*, 441 F.3d at 986-87; *see KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 420 (2007) ("the correct analysis" considers "the field of endeavor at the time of invention and addressed by the patent"). The PTO made neither showing.

1. Neither Deans nor Hall is in the same field of endeavor as Core's invention.

"[T]he appropriate field of endeavor" is determined "by reference to explanations of the invention's subject matter in the patent … , including the embodiments, function, and structure of the claimed invention," "as perceived by one of ordinary skill in the art." *Bigio*, 381 F.3d at 1325-26. Where "the scope [is] explicitly specified in the [invention's] background," that description "confin[es] the field of endeavor." *Id.* at 1325. Importantly, moreover, the "construction of [a] disputed claim term" may be dispositive in a "challenge to the [PTO's] determination that the [asserted] references are analogous art." *Id.* at 1324. To avoid reversal, "the PTO must show adequate support for its findings on the scope of the field of endeavor" in both the "written description and [the] claims." *Id.* at 1326. That support is lacking here. Indeed, in the eyes of a skilled artisan, Core's patents, Deans, and Hall relate to three separate and distinct fields of endeavor.

Core's invention. The "Field of the Invention" subsection in Core's patents explains that "[t]he present invention relates to a method for determining the extent of recovery of materials injected into an oil well." A288(1:13-15). Thus, when the amended claims are properly construed and the "materials injected into an oil well" are limited to hydraulic fracturing fluids, the relevant field of endeavor relates only to determining the extent of recovery in hydraulic fracturing operations. That is

confirmed not only by the claim language discussed above, but by the uncontested definition of an ordinarily skilled artisan.

As Dr. Wooley opined, "[a] person of ordinary skill" in this context would have "three to five years of experience" with the "technology of using tracers *in hydraulic fracturing*." A1584, A1563 (emphasis added). Neither Spectrum nor the PTO offered another definition of a skilled artisan. Thus, based on the specification, the amended claims, and the level of ordinary skill, Core's field of endeavor is limited to using tracers to determine the extent of recovery of hydraulic fracturing fluids in hydraulic fracturing operations.

Deans. By contrast, Deans' "Field of the Invention" relates to "testing or measuring *formation fluids*"—*i.e.*, the naturally occurring liquids and gases in geologic formations—not hydraulic fracturing (or even drilling) fluids. A296(1:13-16) (emphasis added). "More specifically, [Deans] relates to a method of determining the fluid saturations of an immobile fluid phase and at least one mobile fluid phase in a subterranean reservoir." A296(1:16-19).

As the Board acknowledged, Deans relates to "water flooding"—not hydraulic fracturing. A8, A10; *see* A296(1:33-49). And unlike fracturing, "water flooding" is a "secondary" stage of "[r]ecovery of oil from conventional reservoirs such as sands." A1567 (Wooley). "None of the[] stages of conventional recovery," moreover, "involve hydraulic fracturing," which is "a means to increase recovery

from … *un*conventional reservoirs," such as "shales." A1568 (emphasis added). In short, Deans is triply inapposite—it involves a different kind of fluid, in a different kind of oil recovery technique, in a different kind of reservoir.

Hall. Similarly, Hall "relates to monitoring … the circulation of drilling mud in a well during drilling" (A338(1:1-3))—not hydraulic fracturing, which occurs much later (if at all). Specifically, Hall relates "to determin[ing] the 'lag time' of the drilling mud to travel from the surface down the hole, through the drill bit and up to the surface again." A338(1:5-8). Thus, "Hall … is unrelated to production of oil and gas from reservoirs." A1569 (Wooley). Instead, it is only "related to drilling mud used to drill a well, before any production considerations, and particularly before any stimulation consideration such as hydraulic fracturing." *Id*.

The PTO nevertheless treated these diverse fields as one and the same. Ignoring that Core's invention "relates to a method for determining the extent of recovery" of hydraulic fracturing fluids (A288(1:13-15))—and that the ordinarily skilled artisan is one experienced with the "technology of using tracers in hydraulic fracturing" (A1584, A1563)—the Board announced that Core's patents "relate[] to *any operation* in which materials injected into an oil well during oil and gas exploration and production are recovered" (A9-10) (emphasis added). The Board then reasoned that Deans was in that same generalized "field," because "[b]oth water flooding and hydraulic fracturing operations require recovery of material injected

into an oil well and both are operations that occur during oil and gas exploration and production." A10. Similarly, the examiner concluded that Hall was in the same field as Core's invention, because each "requir[es] the injection of materials in oil and gas field operations." A95. The Board and the examiner were mistaken.

As this Court admonished in *Clay*, a reference "cannot be considered to be within [a patent's] field of endeavor merely because both relate to the petroleum industry." 966 F.2d at 659. There, the Board rejected a patent claiming "a process for storing refined liquid hydrocarbon product in a storage tank having a dead volume between the tank bottom and its outlet port," which "involv[ed] preparing a gelation solution which gels after it is placed in the tank's dead volume" and then "can easily be removed." *Id.* at 657. One of "[t]wo prior art references" that the PTO had relied on was "Sydansk," "which disclose[d] a process for reducing the permeability of hydrocarbon-bearing formations and thus improving oil production, using a gel similar to that in Clay's invention." *Id.* at 658.

"The Board … held that Sydansk would have provided one skilled in the art with information that [this] gelation system would have been impervious to hydrocarbons once the system gelled." *Id.* To conclude that Sydansk was analogous art, the PTO had reasoned "that Sydansk and Clay's inventions [we]re part of a common endeavor—'maximizing withdrawal of petroleum stored in petroleum reservoirs.'" *Id.* at 659. This Court reversed, explaining that "Clay's field of endeavor

is the *storage* of refined liquid hydrocarbons," whereas "[t]he field of endeavor of Sydansk's invention … is the *extraction* of crude petroleum." *Id.* By failing to appreciate the significance of that distinction, the Board "erred in considering Sydansk to be within the same field of endeavor as Clay's." *Id.*

This is an *a fortiori* case under *Clay*. Indeed, the Board's asserted "field of endeavor" here—"any operation in which materials injected into an oil well … are recovered" (A9-10)—is even broader than the field of "maximizing withdrawal of petroleum stored in petroleum reservoirs" asserted in *Clay*. Moreover, the PTO's references relate to distinct activities. For example, "[w]ater flooding" (Deans) is "completely different … from hydraulic fracturing," and "[t]he engineers and geologists who design water flooding operations … are not the same people who design fracturing operations." A1614 (Wooley). Although "both operations require the injection of materials into an oil well, combining their teachings is improper because it ignores the differences between these two technologies." *Id.* And drilling (Hall) involves yet another distinct technology: "There is no drill bit in the well when hydraulic fracture fluids are pumped," because drilling occurs long "before any production considerations … such as hydraulic fracturing." A1607, A1569.

In sum, "the first criterion of the analogous art test has not been met," because "the prior art and the claimed subject matter are not in the same field of endeavor." *Wang Labs., Inc. v. Toshiba Corp.*, 993 F.2d 858, 864 (Fed. Cir. 1993)

(holding that "art [wa]s not in the same field of endeavor as the claimed subject matter merely because it relate[d] to [computer] memories"). By ignoring the definition of an ordinarily skilled artisan—one experienced with the "technology of using tracers in hydraulic fracturing" (A1584, A1563)—and by treating water flooding, drilling, and hydraulic fracturing as one and the same type of operation, the Board "erred in considering [Deans and Hall] to be within the same field of endeavor as [Core's invention]." *Clay*, 966 F.2d at 659.

2. Deans and Hall are not reasonably pertinent to the particular problem that Core's invention solved.

Nor are the references on which the PTO relied "reasonably pertinent to the particular problem with which the inventor is involved." *Id*. To satisfy that standard, the PTO must show that the art "logically would have commended itself to an inventor's attention in considering his problem." *Id.* "Thus, the purposes of both the invention and the prior art are important in determining whether the reference is reasonably pertinent." *Id*. Moreover, "[t]he question is not" whether the references "are within the knowledge of … a person of ordinary skill," but "[r]ather … whether an inventor would look to this particular art to solve the particular problem at hand." *QXQ*, 795 F.3d at 1335. Yet the PTO here failed to show that a skilled artisan faced with the problem addressed by Core's invention would have turned to Deans or Hall.

Core's invention. Before Core's methods were invented, "estimating return flow" of hydraulic fracturing materials was "very difficult." A288(1:55-56). As the specification explains, "[i]t would be desirable … to be able to determine how much of a given material is left in an oil well" following "the injection of materials" to fracture the well. A288(1:57-61). Core's patents solve that problem by using "a chemical tracer" in a "method for determining the extent of recovery of materials injected" during hydraulic fracturing. A288(1:66-2:10).

Deans. The problem addressed by Deans is entirely different. Deans identifies a need—"in a formation which is flooded by water"—"to know the residual gas saturation in the portion of [a] formation flooded by water to estimate the recoverable gas in the unflooded portion." A296(1:33-49). Deans solves this problem "by injecting into the formation a measured volume of fluid unsaturated with the immobile fluid and having limited solubility for the immobile liquid." A297(3:6-8). "As the injected fluid flows radially away from the wellbore it dissolves immobile fluid and reduces the immobile fluid saturation." A297(3:14-16). After "the flow is reversed and the injected fluid is produced," "the relative proportions of the immobile and mobile fluids in the formation can be determined." A297(3:16-26).

Deans expressly states that using a "tracer … is not an essential feature of th[e] invention." A299(7:16-18). If a tracer is used at all, its "purpose" is "to aid

in determining the fluid flow characteristics such as fluid drift and dispersion of the injected fluid." A298(6:17-20)), A1608-09 (Wooley). Thus, the "purpose" of Deans' non-essential tracer study—*i.e.*, assessing fluid flow in a water-flooded reservoir—is unlike the problem addressed by Core's patents—*i.e.*, measuring the recovery of hydraulic fracturing fluids.

Hall. So too with Hall, which seeks to determine "the 'lag time' of [a] drilling mud"—*i.e.*, the time it takes for mud to resurface during drilling. A338(1:5-8). Hall solves the problem that "[t]he lag time such as determined in the prior art is not accurate enough for certain applications" by providing a tracer study "for the monitoring of drilling mud circulation in a wellbore." A338(2:6-7, 2:29-41), A1613 (Wooley). Accordingly, the purpose of Hall's tracer study is not related to measuring the *amount* of *fracturing fluid* recovered from a well—the problem solved by Core—but only to measuring the *time* for a *drilling mud* to resurface during drilling.

The PTO ignored these differences. The Board declared that Deans would have been "reasonably pertinent" because it "us[es] recovered tracer concentrations" to measure fluids. A10-11. Likewise, the examiner found it sufficient that "Hall teaches a method … wherein a tracer is added to the aqueous drilling mud" and then measured. A95. But the fact that Deans and Hall involved tracer studies

does not make them "reasonably pertinent to the particular problem" at issue. *Clay*, 966 F.2d at 659. Again, that is the lesson of *Clay*.

There, after concluding that Sydansk was not in the relevant field of endeavor, the Court asked whether it was "reasonably pertinent to the particular problem with which Clay was involved—preventing loss of stored product to tank dead volume while preventing contamination of such product." 966 F.2d at 659-60. Much as the references here all use tracers, Sydansk "us[ed] a gel similar to that in Clay's invention," which the Board found "'would be expected to function in a similar manner'" in "'a number of applications.'" *Id.* at 658-59.

This Court reversed, explaining that the gels in Sydansk and Clay's patent, while "similar," performed unrelated functions: "Sydansk's gel treatment of underground formations functions to fill anomalies so as to improve flow profiles and sweep efficiencies of injection and production fluids through a formation, while Clay's gel functions to displace liquid product from the dead volume of a storage tank." *Id.* at 659. And because "Sydansk [wa]s faced with [a] problem" that was "not reasonably pertinent to the particular problem with which Clay was involved," "[t]he Board's finding" was "erroneous" and "[could not] be sustained." *Id.* at 659, 660.

The PTO made the same mistake here. Much as the use of gels in treating underground oil formations (Sydansk) was not reasonably pertinent to the use of

gels to displace liquid in oil storage tanks (Clay), the use of tracers to evaluate fluid flow in a water-flooded reservoir (Deans) and to time the circulation of drilling mud (Hall) is not reasonably pertinent to the use of tracers to measure the recovery of fracturing fluids (Core). That is especially clear given that "[r]eferences are selected as being reasonably pertinent to the problem *based on the judgment of a person having ordinary skill in the art*." *Kahn*, 441 F.3d at 987 (emphasis added). Wooley, who is such a person, offered undisputed testimony that "[t]he mere fact that two references teach the use of tracers" does not make them analogous, "because tracer studies can be used for a wide variety of applications that are not necessarily pertinent to the particular problem with which the applicant was concerned." A1608.

The vastly differing conditions in which the references use tracers confirms that they are non-analogous. As this Court observed in *Clay*, "[t]he Sydansk process operat[ed] in extreme conditions, with petroleum formation temperatures as high as 115°C and at significant well bore pressures," while "Clay's process apparently operate[d] at ambient temperature and atmospheric pressure." 966 F.2d at 659. Similarly, Core's invention "relates to *high* pressure fracturing of *un*conventional reservoirs while Deans relates to relatively *low* pressure secondary recovery from *conventional* reservoirs." A1608 (Wooley) (emphasis added). Because the

PTO's primary references are "non-analogous art," the rejections below "cannot be sustained." *Clay*, 966 F.2d at 660.

B. Combining the asserted prior art to achieve Core's claimed invention would not have been obvious.

Even assuming that Deans and Hall are analogous art, the PTO's obviousness rejections are incorrect. "Obviousness requires more than a mere showing that the prior art includes separate references covering each separate limitation in a claim under examination." *Unigene Labs., Inc. v. Apotex, Inc.*, 655 F.3d 1352, 1360 (Fed. Cir. 2011). Rather, it is also "important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does." *KSR*, 550 U.S. at 418. In particular, "obviousness requires a motivation or suggestion to combine or modify prior art references, coupled with a reasonable expectation of success." *Boehringer Ingelheim Vetmedica, Inc. v. Schering-Plough Corp.*, 320 F.3d 1339, 1354 (Fed. Cir. 2003). Those prerequisites are not met here.

1. Deans teaches away from hydraulic fracturing.

As an initial matter, a skilled artisan would not have combined Hinkel with Deans, because Deans teaches away from hydraulic fracturing—a necessary element of both Hinkel and Core's amended claims.

"A reference … teach[es] away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the ref-

erence, or would be led in a direction divergent from the path that was taken by the applicant." *DePuy Spine*, 567 F.3d at 1327 (quotation omitted). As a "general rule," "references that teach away cannot serve to create a prima facie case of obviousness." *McGinley v. Franklin Sports, Inc.*, 262 F.3d 1339, 1354 (Fed. Cir. 2001) (quotation omitted). Indeed, "a reference that 'teaches away' from a given combination may negate a motivation to modify the prior art to meet the claimed invention." *Ormco Corp. v. Align Tech., Inc.*, 463 F.3d 1299, 1308 (Fed. Cir. 2006).

Here, Deans expressly discourages using that invention in hydraulic fracturing by warning that "the injection rate should not be so high that the formation will fracture." A299(7:42-43). That instruction is not only contrary to Core's amended claims; it cannot be reconciled with Hinkel's encouragement that "fractures" should be "deliberately introduced in the formation," and that "creat[ing] as large … a fracture zone as possible" is "desirable." A327(2:26-43).

Accordingly, Deans "actually teaches *away* from the Board's posited combination or, at a minimum, provides no evidence of motivation to combine." *Leo*, 726 F.3d at 1355. Because Deans' "teachings undermine the very reason being proffered as to why a person of ordinary skill would have combined" it with Hinkel, "[a]n inference of nonobviousness is especially strong." *DePuy Spine*, 567 F.3d at 1326.

The Board's only response was that "any difference in the injection rate of the brine material in the method for determining fluid saturation of Deans does not amount to a teaching away from applying the tracer study of Deans to the fracturing process of Hinkel." A13. Yet the PTO "cannot pick and choose among individual parts of assorted prior art references"—they "must be read as a whole[,] and consideration must be given where the references diverge and teach away from the claimed invention." *Akzo N.V. v. U.S. ITC*, 808 F.2d 1471, 1481 (Fed. Cir. 1986) (quotation omitted). By "considering the references in less than their entireties" and "disregarding disclosures … [that] teach away," the Board "erred." *Gore*, 721 F.2d at 1550.

2. A skilled artisan would not have been motivated to modify Hinkel's tracer study with either Deans or Hall.

Even apart from Deans' teaching away, the Board's finding that "it would have been obvious to a skilled artisan to use the recovery evaluation procedure of Deans … in the hydraulic fracturing operation of Hinkel" is untenable. A40. A skilled artisan would have seen no reason to modify the tracer study in Hinkel with either Deans or Hall, which address wholly dissimilar problems.

The purpose of Hinkel's invention is "to maximize both the rate of flow and the overall capacity of hydrocarbon" production from fractures. A327(1:18-21). As Hinkel explains, "if fracturing is desirable in a particular instance, then it is also desirable … to create as large (*i.e.*, long) a fracture zone as possible," which pro-

vides "an enlarged flowpath." A327(2:38-43). The problem is, "many wells behave as though the[ir] fracture length were much shorter because the fracture is contaminated with fracturing fluid." A327(2:44-46). "The most difficult portion of the fluid to recover is that retained in the fracture tip—*i.e.*[,] the distal-most portion of the fracture"—because that fluid "must traverse the entire length of the fracture … to be removed." A327(2:48-51), A328(3:12-17). To solve this problem, Hinkel teaches a method in which "the fluid resident in the fracture tip is removed first rather than last." A329(5:60-62). Hinkel calls this procedure "differential mobility," or "DM." A329(6:10-15).

Hinkel does not require the use of tracers, but mentions them only in passing in one example. There, Hinkel says "[t]he effectiveness of DM treatments are simple to verify." A335(17:33). Among several other "indicia … to assess the effectiveness of DM treatments," Hinkel notes that "a tracer study can be performed whereby small amounts of tracers are added to different stages of the fracturing fluid." A335(17:49-50, 17:34-36). "If the method of the present Invention is operable then the tracer study should indicate the first fluid flows back sooner compared with the remainder of the fluid." A335(17:36-40).

As Wooley explained in unrebutted testimony, neither Deans nor Hall is relevant to making that determination. "The Deans method," he testified, "is not described as being capable of making a distinction as to which fluid from a particular

region in a fracture is the first to be recovered from a well." A1609. Instead, Deans teaches only a method to "determin[e] … the residual gas saturation in a watered-out reservoir," and the "purpose for using a tracer is to aid in determining … fluid flow." A297-98(3:50-53, 6:17-20).

Hall is equally inapposite. The examiner found that "it would have been obvious … to use the tracer concentration in the produced/recovered fluid to calculate the amount of injected fluid recovered, as suggested by Hall, in order to determine the effectiveness of the fracture clean-up process disclosed in Hinkel." A82. Yet "Hall has no disclosure or suggestion that it can be used to verify differential mobility of fluids in a well as required by the tracer study described in Hinkel." A1613 (Wooley). Rather, Hall's tracer study is designed only "to determine the 'lag time' of [a] drilling mud" in a well-drilling operation. A338(1:5-8).

Given these disparate objectives, a skilled artisan seeking to improve the tracer study mentioned once in Hinkel would have no reason to modify it with the methods of Deans or Hall—neither of which is suitable for use in Hinkel's tracer study. Indeed, "if a … combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims prima facie obvious." *In re Gardner*, 449 F. App'x 914, 916 (Fed. Cir. 2011). Because the PTO's "combination[s] of references would require … a change in the basic principles under which [Hinkel's

tracer study] was designed to operate," they are "not … proper ground[s] for rejection." *Ratti*, 270 F.2d at 813.

3. A skilled artisan attempting to combine the prior art would not have had a reasonable expectation of success.

"[A]n obviousness determination requires not only the existence of a motivation to combine elements from different prior art references, but also that a skilled artisan would have perceived a reasonable expectation of success." *Medichem*, 437 F.3d at 1165. For this independent requirement to be satisfied, a skilled artisan "must be motivated to do more than merely to vary all parameters or try each of numerous possible choices until one possibly arrived at a successful result." *Id*. (quotation omitted). Where "the prior art g[ives] only general guidance as to the particular form of the claimed invention or how to achieve it," it "fails to provide the requisite 'reasonable expectation' of success." *Id*. (quotation omitted).

Here, "[t]he fact that a particular tracer study may be useful for one type of application" in the petroleum industry "does not necessarily mean that the same tracer study would be useful for hydraulic fracturing." A1613 (Wooley). "[H]ydraulic fracturing applications typically involve injecting fluid into a reservoir at very high speeds and pressures," whereas "[f]luid flow studies … involve injecting fluid into a reservoir very slowly, and then usually shutting-in the well and/or waiting several weeks, months, or even years for the injected fluid to flow

through the reservoir and be produced." *Id.* "These differences between applications necessarily lead to differences in the tracer studies." *Id.*

Take Hinkel and Deans. In the fluid-flow tracer study of Deans, fluid is "injected into the formation at a rate of 159 m^3 per day." A297(4:16-17). In the hydraulic-fracturing tracer study mentioned in Hinkel, by contrast, "[v]arious fluids are injected into the formation at a rate of 45 barrels per minute," which is "approximately 7 m^3 per *minute*"—or 10,080 m^3 per day, *63 times* as fast as in Deans. A1609-10 (Wooley), A332-33 (tbl. 2).

Hall applies another set of constraints. There, the tracer is *discontinuously* "inject[ed]" into the supply mud every "few seconds" in "a series of … tracer pulses." A340(5:20-26); A340(6:25-34). As Wooley showed, "[t]his differs from hydraulic fracturing operations, wherein the tracer is typically admixed continuously into the stream of injected fracturing fluid." A1613.

As these variables illustrate, "[h]ydraulic fracturing, water flooding, fluid flow studies, and drilling are each very different processes," and "[a] tracer study that is effective for [one] is not necessarily going to be effective in [another], because of the differences in the types of injected material, the amount of injected material, the tracer concentration, the rate of injection, the fluid pressure in the injected material, the length of time the tracer spends in the formation, and the rate of production, among other things." A1615. Moreover, these parameters are espe-

cially unpredictable in well-fracturing, which Hinkel describes as "a highly complex operation performed with precise and exquisite orchestration of equipment." A327(2:1-3).

The Board dismissed these manifold discrepancies, asserting that "[Core] has directed us to no persuasive evidence that the tracer study evaluations of Deans would not be reasonably expected to work in the hydraulic fracturing operation of Hinkel." A13. Yet that was not Core's burden—the "burden of showing a prima facie case of obviousness" is on "[t]he Patent Office." *Kennametal, Inc. v. Ingersoll Cutting Tool Co.*, 780 F.3d 1376, 1384 (Fed. Cir. 2015). The PTO did not carry that burden here.

Indeed, there is no evidence—let alone "substantial" evidence—that a skilled artisan could have predicted the necessary adjustments to combine Hinkel, Deans, and Hall. Because "the prior art gave … no indication of which parameters were critical," and "no direction as to which of many possible choices [wa]s likely to be successful," the PTO's "hindsight claims of obviousness" "should [be] reject[ed]." *In re Cyclobenzaprine Hydrochloride Extended-Release Capsule Patent Litig.*, 676 F.3d 1063, 1071 (Fed. Cir. 2012) (quotation omitted).

III. The PTO erred in disregarding objective indicia of nonobviousness.

A. Uncontroverted testimony demonstrated a nexus between the patents and Core's commercial service.

Even assuming that the PTO established a prima facie case of obviousness, Core amply rebutted it with objective evidence that its invention would not have been obvious. Under this Court's precedent, "consideration of the objective indicia is *part of* the whole obviousness analysis, not just an afterthought." *Leo*, 726 F.3d at 1357. "Objective indicia 'can be the most probative evidence of nonobviousness,'" and "are crucial in avoiding the trap of hindsight when reviewing, what otherwise seems like, a combination of known elements." *Id*. at 1358 (citation omitted). Thus, "objective evidence of nonobviousness must be considered." *In re GPAC Inc.*, 57 F.3d 1573, 1580 (Fed. Cir. 1995).

For objective evidence to be given "substantial weight," there must be "a nexus between the evidence and the merits of the claimed invention." *Id*. "A prima facie case of nexus is generally made out when the patentee shows both that there is commercial success, and that the [method] that is commercially successful is the invention disclosed and claimed in the patent." *Id*. (quotations omitted).

Core presented extensive objective evidence of nonobviousness here. Specifically, Core submitted testimony from Thomas Hampton—a named inventor and past president of Core's ProTechnics division, whose SpectraChem service uses tracers to measure recovery in hydraulic fracturing operations. A480-84. Core al-

so submitted testimony from Michael Flecker—ProTechnics's president after Hampton and its former Director of Technology and Manager of Engineering. A984-87. Both Hampton and Flecker had "firsthand, personal knowledge of the market for chemical tracers as well as [ProTechnics's] sales, customers, and the demand for the chemical tracer." A481, A985.

As Hampton and Flecker explained, before Core's invention there was a need "for some diagnostic tool to determine the extent of recovery of hydraulic fracturing fluid." A481, A1018-19, A986-87. This is evidenced by the fact that "[t]he subject matter of [Core's patents] has been copied by three companies." A482, A1019. Moreover, Core's "customers have praised the services that Pro-Technics provides under [Core's patents]," and ProTechnics's revenues reflect the service's popularity with those consumers. A482-83; A1019-20. Revenues from the SpectraChem service exceed $100 million, and SpectraChem experienced "increased revenue growth even during a period of economic downturn and lower rig counts"—until Spectrum caused "price erosions of as much as 80%." A985-86.

Yet the PTO disregarded these objective indicia of nonobviousness, finding that no nexus existed between ProTechnics's SpectraChem service and Core's patents. According to the PTO, insufficient evidence showed that the SpectraChem service performs the claimed method's "calculating" step, which requires "calculating the amount of admixture recovered from the oil well using the concentration

of the chemical tracer present in the production fluid as a basis for the calculation." A291(7:46-50).

This erroneous determination led the Board to give insufficient weight to the objective indicia showing that the methods taught by Core's patents were not obvious. As Hampton's uncontroverted testimony explained, ProTechnics uses a mass balance approach to calculate the amount of admixture recovered. Even the Board acknowledged that "Hampton … would have personal knowledge of the services provided by ProTechnics." A45. Yet the Board discounted this testimony, declining to give it "substantial weight … without corroborating evidence." *Id.* The problem is, Core *did* offer extensive corroborating evidence, and Spectrum offered *no* contrary evidence. Moreover, Spectrum's silence in this regard is telling, as its president and co-founder was formerly a senior manager at Core who testified that he had "intimate familiarity" with the patented methods. A1596(105:9-20). Thus, if Core did *not* practice its patents, there is every reason to believe Spectrum would have offered evidence to that effect. It did not.

Given that all the evidence supported Hampton's explanation of his own company's process, the Board erred in discounting it. *First*, the brochure for the SpectraChem service states that "ProTechnics performs th[e] ['calculating'] step by either using a mass balance approach or a relative rate of recovery." A44. This

brochure further "states that 'SPECTRACHEM tracers are routinely used to quantify and profile frac fluid clean-up.'" A1018.

Second, Hampton provided a sample flow back report that "is typical of the reports ProTechnics provides to its clients after performing a tracer job." A1017. This report "demonstrates that ProTechnics analyzes the samples for the concentration of the tracer fluid." A1018. A graph shows "the concentration of each tracer over time"—including the fact that at certain stages, "the tracer concentration was zero, indicating that there was *no flowback* from these two stages of the well." *Id*. (emphasis added); A501. In other words, this process required "calculating" that "the amount of admixture recovered from the oil well" in this instance was zero—fulfilling the "calculating" claim limitation.

Finally, Hampton himself explained—without contradiction—"that the tracer concentrations were used to determine the amounts of fluid that were flowing back." A1018. Thus, uncontroverted testimony from an inventor who was ProTechnics' president provided "firsthand, personal knowledge that ProTechnics' SpectraChem tracing services practice every limitation of the amended claim," including "a claim chart that explained how ProTechnics' SpectraChem tracing services practice every limitation." A1016-17.

Despite its "intimate familiarity" with Core's methods (A1596(105:9-20)), Spectrum offered no reason to doubt Hampton's knowledge of his company's pro-

cess. Spectrum offered no evidence at all, let alone evidence that ProTechnics does not practice the mass balance approach. Nor did Spectrum explain how a report that calculates the "amount of admixture recovered" as zero fails to "calculat[e] the amount of admixture recovered." Given the absence of any evidence undermining Core's extensive proof that it uses the mass balance approach and "determine[s] the amounts of fluid that were flowing back" (A1018), the Board erred in finding that Core "failed to establish by preponderance of the evidence that ProTechnics' SpectraChem services" performs the "calculating" step (A50). *See Berges v. Gottstein*, 618 F.2d 771, 774 (C.C.P.A. 1980) (holding that "[t]he board erred in holding that the affidavits are merely bottomed on hearsay" where "the evidence unquestionably corroborates [the declarants'] assertion[s]").

B. The length of time between the prior art relied on by the PTO and the invention here confirms its patentability.

Beyond commercial success and related economic indicators that require a "nexus" between the invention and a commercial embodiment, the Board improperly disregarded another objective indicator: "[t]he length of the intervening time between the publication dates of the prior art and the claimed invention." *Leo*, 726 F.3d at 1359. Where there is substantial "intervening time between the prior art's teaching" and the development of an invention, that evidence "speaks volumes to [its] nonobviousness." *Id.* Thus, in *Leo*, this Court confronted a patent filed in 2000, and two prior art patents issued in 1978 and 1986—22 and 14 years earlier,

respectively. *Id.* The Court held that the "intervening time between the prior art's teaching[s]"—which supposedly rendered the patent obvious—and the patent there showed that it was not obvious. *Id.* Relying on such "objective indicia, as opposed to the hindsight lens used by the Board," the Court reversed the Board's obviousness determination. *Id.*

Likewise here, Core's patent applications were filed in 2001, but Deans issued in 1978—23 years earlier. And although Hinkel was filed in 1998, the teaching that the Board relied on—*i.e.*, "the importance of ensuring maximum recovery of injected hydraulic fracturing material" (A41)—was not new to Hinkel, but has been known ever since hydraulic fracturing was invented. As a reference cited below explains, "a basic assumption in fracturing *has always been* that cleaner fracture will produce reservoir fluids at a higher rate." A482 (emphasis added); A491. Similarly, a 1987 patent cited by Hinkel explains: "After completion of the fracturing treatment, the fluid is recovered from the formation and the proppant remains to hold the fracture faces apart." U.S. Patent No. 4,702,848 (1:29-31). Likewise, Hall was filed in 1988, and many other cited references are older—some going back as far as 1962.

Thus, the teachings that the Board combined had been known in the art for decades—confirming that Core's claimed inventions would not have been obvious. This objective fact about the "intervening time between the prior art's teaching"

and the teachings of Core's patents "speaks volumes to the[ir] nonobviousness." *Leo*, 726 F.3d at 1359.

CONCLUSION

The PTO's "combination of elements from non-analogous sources, in a manner that reconstructs [Core's] invention only with the benefit of hindsight, is insufficient to present a prima facie case of obviousness." *In re Oetiker*, 977 F.2d 1443, 1447 (Fed. Cir. 1992). As amended and correctly construed, Core's independent claims are patentable over the prior art—particularly given the strong objective indicia of nonobviousness. And "[s]ince dependent claims are nonobvious if the independent claims from which they depend are nonobvious, the Board's affirmance of the rejection of [Core's] dependent claims" must "also [be] reversed." *In re Fritch*, 972 F.2d 1260, 1266 (Fed. Cir. 1992).

Respectfully submitted,

/s/ Steffen N. Johnson

STEFFEN N. JOHNSON
EIMERIC REIG-PLESSIS
CHRISTOPHER E. MILLS
Winston & Strawn LLP
1700 K Street, N.W.
Washington, DC 20006
(202) 282-5000
sjohnson@winston.com
ereigplessis@winston.com
cmills@winston.com

J. DEAN LECHTENBERGER
Winston & Strawn LLP
1111 Louisiana Street
Houston, TX 77002
(713) 651-2600
jlechtenberger@winston.com

TANYA L. CHANEY
Shook, Hardy & Bacon, LLP
600 Travis Street, Ste. 3400
Houston, TX 77002
(713) 227-8008
tchaney@shb.com

Counsel for Appellant

SEPTEMBER 30, 2015

ADDENDUM

ADDENDUM TABLE OF CONTENTS

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
95/002,141	09/06/2012	6,659,175 B2	COR-1026-US-RE	5065

87627 7590 03/24/2015
Mossman, Kumar & Tyler PC
P.O. Box 421239
Houston, TX 77242

EXAMINER	
XU, LING X	

ART UNIT	PAPER NUMBER
3991	

MAIL DATE	DELIVERY MODE
03/24/2015	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SPECTRUM TRACER SERVICES, LLC.
Requester

v.

CORE LABORATORIES LP
Patent Owner and Appellant

Appeal 2015-000198
Reexamination Control 95/002,141
Patent 6,659,175 B2
Technology Center 3900

Before CHUNG K. PAK, JEFFREY B. ROBERTSON, and RAE LYNN P. GUEST, *Administrative Patent Judges*.

GUEST, *Administrative Patent Judge*.

DECISION ON APPEAL

I. STATEMENT OF CASE

This is a decision on appeal by Core Laboratories LP (hereinafter "Patent Owner")[1] from the Patent Examiner's decision to reject pending claims 1-7, 9, and 11 in an *inter partes* reexamination of U.S. Patent 6,659,175 B2 (hereinafter, "the '175 Patent"). The Board's jurisdiction for this appeal is under 35 U.S.C. §§ 6(b), 134(b), and 315(a).

The '175 patent is related to U.S. Patent 7,032,662 B2 ("the '662 Patent"), which is the subject of Reexamination Control 95/002,144, also currently on appeal. The '175 Patent and the '662 Patent are the subjects of a litigation in the U.S. District Court for the Western District of Oklahoma styled *Core Laboratories LP v. Spectrum Tracer Services, LLC*, Case No. 11-cv-1157-M. The litigation is stayed pending the outcome of these reexamination proceedings.

We concurrently heard oral arguments from Patent Owner and Requester concerning the reexaminations of the '175 Patent and '662 Patent on February 11, 2015, a written transcript of which will be entered into the electronic record in both cases in due course.

We AFFIRM.

II. BACKGROUND

The '175 Patent issued December 9, 2003, to Scott Malone et al. A request for *inter partes* reexamination under 35 U.S.C. §§ 311-318 and 37 C.F.R. §§ 1.902-1.997 for the '175 Patent was filed September 6, 2012 by a Third-Party Requester, Spectrum Tracer Services, LLC, (hereinafter

---

[1] *See* Patent Owner's Supplemental Appeal Brief, filed June 13, 2014 ("App. Br.") 2.

"Requester"). Request for *Inter Partes* Reexamination 1; Requester's Respondent Brief, filed May 23, 2014 (hereinafter "Res. Br.") 1.

Claims 1-11 were original to the '175 patent. Claim 10 was not subject to reexamination, and claim 8 was cancelled during this proceeding. Claims 1–7, 9 and 11 stand rejected and are currently appealed. Right of Appeal Notice mailed February 7, 2014 (hereinafter "RAN") 1; App. Br. 3.

The '175 Patent relates to a method for determining the extent of recovery of materials injected into an oil well during oil and gas exploration and production using chemical tracers. '175 Patent, col. 1, ll. 16-19.

Claim 1 is representative of the claims on appeal and reads as follows, (with underlining showing language added during reexamination and indentations added for clarity).

> 1. A method for determining the extent of recovery of materials injected into an oil well comprising the steps of:
>
> a) preparing a material to be injected into an oil well<u>, wherein the material injected into the oil well is a material useful for hydraulically fracturing the oil well</u>;
>
> b) admixing therewith a chemical tracer compound at a predetermined concentration;
>
> c) injecting the admixture into an oil well;
>
> d) recovering from the oil well a production fluid;
>
> e) analyzing the production fluid for the concentration of the chemical tracer present in the production fluid; and
>
> f) calculating the amount of admixture recovered from the oil well using the concentration of the chemical tracer present in the production fluid as a basis for the calculation.

App. Br. 8 and Claims App'x. Independent claim 11 is substantially identical to claim 1, but further recites that "the tracer is a fluorinated benzoic acid." *Id.* The Examiner maintains the following rejections on appeal. *See* App. Br. 6-7.

I. The Rejection of claims 1, 5 and 6 under 35 U.S.C. § 103(a) as obvious in view of Hinkel[2] in view of Deans[3] or Hall.[4] *See* Grounds I and IX, RAN 5-7 and 19-21.

II. The Rejection of claims 2–4, 9, and 11 under 35 U.S.C. § 103(a) as obvious over Hinkel and Deans or Hall and further in view of Dugstad.[5] *See* Grounds II and X, RAN 7-10 and 21-22.

III. The Rejection of claims 5–7 under 35 U.S.C. § 103(a) as obvious over Hinkel and Deans and further in view of Chen,[6] Hoots[7] or Greenkorn[8] or Hinkel and Hall and further in view of Chen or Hoots. *See* Grounds III, IV, VI, XI, and XII, RAN 10–12, 14-15, and 22-26.

IV. The Rejection of claims 5 and 6 under 35 U.S.C. § 103(a) as obvious over Hinkel and Deans and further in view of Teasdale.[9] *See* Ground V, RAN 13–14.

V. The Rejection of claims 2–4 and 11 under 35 U.S.C. § 103(a) as obvious over Hinkel, Deans, and Teasdale or Greenkorn, or

---

[2] US 6,192,985 B1, issued Feb. 27, 2001, to Hinkel et al.
[3] US 4,090,398, issued May 23, 1978, to Deans et al.
[4] EP 0 282 232 A2, published Sep. 14, 1988, listing Christopher Hall as inventor.
[5] Dugstad, et al., "Application of Tracers to Monitor Fluid Flow in the Snorre Field: A Field Study," Society of Petroleum Engineers, Publication No. SPE 56427 (1999).
[6] US 4,303,411, issued Dec. 1, 1981 to Chen et al.
[7] US 4,783,314, issued Nov. 8, 1988 to Hoots et al.
[8] Greenkorn, Robert A., "Experimental Study of Waterflood Tracers," Society of Petroleum Engineers, Publication No. SPE 169 (January 1962).
[9] US 4,223,725, issued Sep. 23, 1980 to Teasdale et al.

Hinkel and Hall, further in view of Bowman.[10] *See* Grounds VII, VIII, XIII, RAN 16-19 and 26-27.

Patent Owner relies on the testimony of J. Thomas Hampton. *See* Rule 132 Technical Declaration of J. Thomas Hampton, dated January 15, 2013 (hereinafter the "First Hampton Declaration") (App. Br. 14); Rule 132 Technical Declaration of J. Thomas Hampton, dated September 1, 2013 (hereinafter the "Supplemental Hampton Declaration") (App. Br. 10).[11] Patent Owner also relies on the testimony of Dr. Gary Wooley. *See* Rule 132 Technical Declaration of Gary Wooley, dated January 15, 2013 (hereinafter the "First Wooley Declaration"); Rule 132 Supplemental Technical Declaration of Gary Wooley, dated September 16, 2013 (hereinafter the "Second Wooley Declaration) (App. Br. 10). Patent Owner also relies on the

[10] Bowman, R.S., "Evaluation of Some New Tracers for Soil Water Studies," 48 Soil Sci. Soc. Am. J. 987-993 (1984).

[11] With the Appeal Brief filed June 13, 2014, Patent Owner submitted a "Rule 132 Technical Declaration of J. Thomas Hampton," dated January 15, 2013 as the "First Hampton Declaration," which includes no exhibits, and a second "Rule 132 Technical Declaration of J. Thomas Hampton," which is also dated January 15, 2013, as the "Second Hampton Declaration," which includes Exhibits A–K. It is clear from the record that Patent Owner intended to submit the "Second Hampton Declaration," dated January 15, 2013 as the "First Hampton Declaration" because of the citations in the Appeal Brief to Exhibits A–K of the "First Hampton Declaration." It is also clear from the record that Patent Owner intended to submit an entirely different declaration as the "Second Hampton Declaration," namely, the "Rule 132 Supplemental Technical Declaration of J. Thomas Hampton" that was executed on September 1, 2013, and made of record on September 16, 2013. The error is apparent because Patent Owner specifically identifies the separate declarations by execution date (*see* App. Br. 10 and 14) and refers to paragraph numbers and Exhibits consistent therewith.

testimony of Mr. Michael J. Flecker, dated September 16, 2013 (referred to by Patent Owner as the "Flecker Declaration") (App. Br. 17).

Requester relies on the testimony of Alfred Roy Jennings, Jr. *See* Declaration of Alfred Roy Jennings, Jr., P.E., dated February 20, 2013 (hereinafter "First Jennings Declaration") (Res. Br. 5); Supplemental Declaration of Alfred Roy Jennings, Jr., P.E., dated October 3, 2013 (hereinafter "Supplemental Jennings Declaration") (Res. Br. 9).

A. Hinkel and Deans (Ground I, RAN 5–7)

Claims 1 and 5-6

The dispositive issue on appeal is:

Does a preponderance of the evidence support Patent Owner's contention that the Examiner erred in determining that it would have been obvious for one of ordinary skill in the art to use tracer data to determine the extent of recovered material that has been injected into an oil well, as taught by Deans, in a hydraulic fracturing operation in which recovery of all of the injected fracturing fluid is necessary for optimum hydrocarbon recovery, as described in Hinkel? We answer this question in the negative.

Patent Owner initially argues that the Examiner erred in interpreting the language added to claim 1 during reexamination, namely "the material injected into the oil well is a material useful for hydraulically fracturing the oil well." According to Patent Owner, this language, read in light of the disclosure of the '175 Patent, indicates that the claim is limited to a method of determining the extent of recovery of hydraulic fracturing fluid in a hydraulic fracturing operation. App. Br. 8–17. The Examiner determined

that the claim is not limited to a hydraulic fracturing operation. RAN 4–5 and 43–44; Res. Br. 2–3.

Even assuming that the claim is limited to hydraulic fracturing, Hinkel discloses an admixture of a hydraulic fracturing fluid and a tracer used in a hydraulic fracturing operation. *See* RAN 5–6 ("Hinkel further discloses that tracers can be added to the various fracturing fluid stages in actual field applications so that a tracer study can be performed to verify the effectiveness of the fracture clean-up process (see Example 4)."); Res. Br. 8 ("Hinkel teaches the use of a tracer study in a staged fracturing operation and provides clear and repeated motivation for determining the amount of fracturing fluid recovered."). Hinkel teaches admixing a tracer and a material useful for hydraulically fracturing an oil well, namely hydraulic fracturing fluid. Col. 3, ll. 9-19; Ex. 4.

Patent Owner contends that one of ordinary skill in the art would not have looked to the tracer study of Deans, which includes the steps of (e) analyzing the production fluid for the concentration of the chemical tracer and (f) calculating the amount of admixture recovered from the oil well using the concentration of the chemical tracer, for use in the hydraulic fracturing operation of Hinkel. App. Br. 20–22. Patent Owner argues that one of ordinary skill in the art would have no reason to look to Deans because (a) Deans' water flooding operation is non-analogous art to Hinkel's hydraulic fracturing operation, (b) Deans' tracer study is for a different purpose than Hinkel's tracer study, and (c) Deans teaches away from a hydraulic fracturing operation. *Id.* Thus, Patent Owner argues that hydraulic fracturing and water flooding operations are not in the same field of

endeavor. App. Br. 22. Dr. Wooley explains the differences between these two operations. Wooley First Decl. ¶ 12–14; *see also* Wooley Second Decl. ¶ 15, 19, and 20. Nonetheless, Dr. Wooley admits that "it is true that both operations require the injection of materials into an oil well," Wooley Second Decl. ¶ 19.

Whether a prior art reference is "analogous" is a question of fact. *In re Clay*, 966 F.2d 656, 658 (Fed. Cir. 1992). "The analogous-art test requires that the Board show that a reference is either in the field of the applicant's endeavor or is reasonably pertinent to the problem with which the inventor was concerned in order to rely on that reference as a basis for rejection." *In re Kahn*, 441 F.3d 977, 986-987 (Fed. Cir. 2006) (citing *In re Oetiker*, 977 F.2d 1443, 1447 (Fed. Cir. 1992)). "The rationale behind this rule precluding rejections based on combination of teachings of references from nonanalogous arts is the realization that an inventor could not possibly be aware of every teaching in every art. Thus, we attempt to more closely approximate the reality of the circumstances surrounding the making of an invention by only presuming knowledge by the inventor of prior art in the field of his endeavor and in analogous arts." *In re Wood*, 599 F.2d 1032, 1036 (CCPA 1979). The question is not whether the combined art is analogous to each other, but whether the combined references are each analogous to the "applicant's endeavor." *Id.*

We are not persuaded that the field of endeavor of the '175 Patent is limited to hydraulic fracturing. Rather, the inventor's field of endeavor is determined by the disclosure of the '175 Patent. *See Wood*, 599 F.2d at 1036. The '175 Patent is not limited to hydraulic fracturing, but rather is

related to any operation in which materials injected into an oil well during oil and gas exploration and production are recovered. *See* '175 Patent, col. 1, ll. 13-23 and 41-63. Both water flooding and hydraulic fracturing operations require recovery of material injected into an oil well and both are operations that occur during oil and gas exploration and production.

Even if the field of endeavor is properly limited to determining amount of fracturing fluid recovered from a hydraulic fracturing operation, as argued by Patent Owner, both Hinkel and Deans are reasonably pertinent to the problem with which the inventor was concerned. "A reference is reasonably pertinent if ... it is one which, because of the matter with which it deals, logically would have commended itself to an inventor's attention in considering his problem. If a reference disclosure has the same purpose as the claimed invention, the reference relates to the same problem, and that fact supports use of that reference in an obviousness rejection." *Innovention Toys, LLC v. MGA Entm't, Inc.*, 637 F.3d 1314, 1321 (Fed. Cir. 2011) (quoting *Clay*, 966 F.2d at 659); *see also In re Klein*, 647 F.3d 1343, 1348 (Fed. Cir. 2011). "References are selected as being reasonably pertinent to the problem based on the judgment of a person having ordinary skill in the art." *Kahn*, 441 F.3d at 986-987.

Hinkel would have been reasonably pertinent because it relates to recovery of fracturing material in a hydraulic fracturing process and using tracer studies to evaluate the effectiveness of the recovery. Patent Owner argues that Deans is not related to determining the amount of fluid recovered, but rather to determining the fluid saturations of immobile fluid phase and a mobile fluid phase in a subterranean reservoir. Reb. Br. 12.

However, Deans teaches that not only can return tracer concentrations be used to determine "the dissolved immobile fluid concentration," but that the return tracer concentration can also be used to determine "when the total volume of fluid injected into the formation has been produced." Deans, col. 6, ll. 22–28. According to Deans, "knowledge of when the volume of injected fluid has been produced can be determined either by knowing the total injected fluid volume or by measuring the tracer concentration profile in the produced fluid and determining the injected fluid volume using general engineering principles." *Id.* at ll. 28–33. Thus, Deans would also be reasonably pertinent since it teaches a method to determine the extent of recovery of a fluid injected into an oil well, i.e. the volume of fluid injected into the formation that has been produced, using recovered tracer concentrations, which is the same purpose of the tracer as in the claimed invention. Accordingly, both Hinkel and Deans are analogous art to the present invention.

Therefore, we turn to the question of whether it would have been obvious to a skilled artisan to use the recovery evaluation procedure of Deans to determine the full extent of recovery of the hydraulic fracturing fluid in the hydraulic fracturing operation of Hinkel.

Patent Owner argues that the purpose of the tracer in Hinkel is different than the purpose of the tracer in Deans, and that the processes are too different for the skilled artisan to expect success in using the tracer study of Deans in a hydraulic fracturing operation such as Hinkel. App. Br. 22–24.

The Examiner stated that it would have been obvious to use the tracer study of Deans in the hydraulic fracturing operation of Hinkel "in order to determine the effectiveness of the fracture clean-up process disclosed in Hinkel." RAN 7. Hinkel explains the importance of deliberately removing the fracturing fluid from the fracture, i.e. "clean-up," for example, to avoid the presence of fluid acting as a barrier to the migration of hydrocarbon from the formation. Hinkel, col. 2, l. 44 to col. 3, l. 38. While the diagnostics discussed in Hinkel are directed to the improvement in removing fluid retained in the distal-most portion of the fracture from the wellbore (*id.*), the Examiner is relying on the diagnostics of Deans not the diagnostics of Hinkel. RAN 7. Hinkel nonetheless teaches the importance of ensuring maximum recovery of injected hydraulic fracturing material. Accordingly, we agree with the Examiner that Hinkel provides sufficient reason for the skilled artisan to evaluate the extent of admixture recovered.

Patent Owner has not persuasively demonstrated by a preponderance of the evidence that the tracer study of Deans would be either incapable of working or not expected to work in the hydraulic fracturing operation of Hinkel. Since Hinkel uses known tracers in hydraulic fracturing operations, one of ordinary skill in the art would have expected that the extent of recovery could be determined using tracer measurements and material balances described in Deans.

Finally, Patent Owner argues that Deans "teaches away" from a hydraulic fracturing operation by requiring an injection rate of the brine material that is low enough to avoid fracturing the formation. App. Br. 21–22; *see* Deans, col. 7, ll. 42–43. A reference "teaches away" when it

suggests that the developments flowing from its disclosures are unlikely to produce the objective of the Appellants' invention. *See In re Gurley,* 27 F.3d 551, 553 (Fed. Cir. 1994). Additionally, a reference may "teach away" from a use when that use would render the result inoperable. *McGinley v. Franklin Sports, Inc.*, 262 F.3d 1339, 1354 (Fed. Cir. 2001) ("If references taken in combination would produce a "seemingly inoperative device," we have held that such references teach away from the combination and thus cannot serve as predicates for a prima facie case of obviousness.").

Patent Owner's argument that Deans teaches away from the claimed invention is directed to the injection rate of brine in Deans, while the rejection of record is directed to the hydraulic fracturing operation of Hinkel. Dr. Wooley discusses the difference between the injection processes of Hinkel and Deans. Wooley First Decl. ¶ 12-15. However, any difference in the injection rate of the brine material in the method for determining fluid saturation of Deans does not amount to a teaching away from applying the tracer study of Deans to the fracturing process of Hinkel.[12]

As discussed above, Patent Owner has directed us to no persuasive evidence that the tracer study evaluations of Deans would not be reasonably expected to work in the hydraulic fracturing operation of Hinkel or would somehow make the hydraulic fracturing operation inoperable. In fact, the evidence as a whole supports otherwise because Hinkel clearly discloses tracer materials successfully used and recovered during hydraulic fracturing

[12] Nonetheless, Deans' teaching that the injection rate should not be so high that the formation will fracture (Deans, col. 7, ll. 42-43) is evidence that brine materials might be substituted for other known fracturing fluids in a fracturing operation provided that the brine material is injected at a high enough flow rate.

operations. Therefore, we are not persuaded that one of ordinary skill in the art would be dissuaded from applying the tracer study of Deans to the hydraulic fracturing operation disclosed in Hinkel.

Secondary Considerations of Non-obviousness

Patent Owner relies on the First and Second declarations of Mr. J. Thomas Hampton, the declaration of Mr. Michael J. Flecker, and the Second Declaration of Dr. Wooley as evidence of non-obviousness based on secondary consideration, namely that ProTechnics' SpectraChem service satisfied a long felt but unmet need in the art, was copied, received industry praise, and was commercially successful. App. Br. 17–19.

For objective evidence to be accorded substantial weight, Patent owner must establish a nexus between the evidence and the merits of the claimed invention. *In re GPAC*, 57 F.3d 1573, 1580 (Fed. Cir. 1995) (appellant offers no evidence that the market reaction to appellants' invention is rooted in the subject matter claimed). Put another way, commercial success or other secondary considerations may presumptively be attributed to the claimed invention only where "the marketed product embodies the claimed features, and is coextensive with them." *Ormco Corp. v. Align Tech. Inc.,* 463 F.3d 1299, 1311-12 (Fed. Cir. 2006) (*quoting Brown & Williamson Tobacco Corp. v. Phillip Morris, Inc.,* 229 F.3d 1120, 1130 (Fed. Cir. 2000)).

The Examiner found that there was insufficient evidence to find a nexus between the SpectraChem service offered by ProTechnics and the claimed method for the evidence to having meaningful weight in an obviousness analysis. *See* RAN 42. In particular, the Examiner determined

that the evidence did not support a finding that the SpectraChem service included the step of "calculating the amount of admixture recovered from the oil well using the concentration of the chemical tracer present in the production fluid as a basis for the calculation." *See* RAN 71.

Mr. Hampton testifies that the SpectraChem service provided by ProTechnics corresponds to the subject matter of Amended Claims 1 and 8. *See* First Hampton Decl. ¶ 11.[13] To corroborate this testimony, Mr. Hampton points to Exhibit H, which is a claim chart prepared by Mr. Hampton, and Exhibit I, which is a brochure of ProTechnics' services. In Exhibit H, Mr. Hampton states

> The attached brochure verifies that Step f) is performed. SPECTRACHEM tracers are routinely used to quantify and profile frac fluid clean-up and flowback efficiency over time.
>
> ProTechnics performs this step by either using a mass balance approach or a relative rate of recovery.

First Hampton Decl., Exhibit H, p. 1-2. The second sentence is a quote from the fourth page of the brochure submitted as Exhibit I. Mr. Hampton then cites to a *Markman* ruling in a district court litigation involving the '175 Patent. Mr. Hampton further testifies that he had explained during a preliminary injunction hearing that ProTechnics performs step f) by either a mass balance approach or a relative rate of recovery approach and that "the tracer concentrations were used to determine the amounts of fluid that were flowing back." *See* Supplemental Hampton Decl. ¶ 20 (citing Exhibit A to

---

[13] While Dr. Wooley and Mr. Flecker provide additional testimony of secondary considerations of non-obviousness, they provide no persuasive testimony regarding the nexus between ProTechnics' SpectraChem service and the claimed method.

the Declaration, 29, l. 1 to 32, l. 5).[14] Accordingly, Patent Owner is relying on the testimony of Mr. Hampton as someone with personal knowledge of the services provided and an expert in the field in describing a "rate of recovery" determination. *See* App. Br. 18 ("The Examiner either discounted or ignored Mr. Hampton's declaration testimony that Appellant's services do include the 'calculating' step. *See, e.g.*, Second [Supplemental] Hampton Dec. ¶ 20 (testifying that 'the tracer concentrations were used to determine the amounts of fluid that were flowing back.').")

Although Mr. Hampton, as president of the ProTechnics division of Core Laboratories, would have personal knowledge of the services provided by ProTechnics, we decline to give substantial weight to the testimony of Mr. Hampton without corroborating evidence that ProTechnics performs the additional step of calculating the amount of admixture recovered from the tracer concentration data. *See, e.g., Am. Acad. of Sci. Tech. Ctr.*, 367 F.3d at 1368 ("[T]he Board is entitled to weigh the declarations and conclude that the lack of factual corroboration warrants discounting the opinions expressed in the declarations."); *In re Etter*, 756 F.2d 852, 859-60 (Fed. Cir. 1985) (opinion affidavit asserting the reference disclosed obsolete technology was correctly characterized by the board "as merely representing opinion[]

[14] During the Preliminary Injunction Hearing, Mr. Hampton testified that the Report demonstrates tracer concentration recovery per stage of operation and total tracer concentration recovery. When asked "Can you explain how the relative rate of recovery satisfies the claim element of calculating the amount of admixture recovered?" Mr. Hampton points to where in the Report "we just add the amount of chemical coming back from each stage so that you can see the total amount of chemical tracer coming back on that particular job." Exhibit A, filed with Patent Owner's Response to the Action Closing Prosecution on September 16, 2013, 29, l. 1 to 32, l. 5.

unsupported by facts and thus entitled to little or no weight") (citing *In re Piasecki*, 745 F.2d 1468, 1472-73 (Fed. Cir. 1984); *In re Rinehart*, 531 F.2d 1048, 1052 (CCPA 1976)).

The language of the SpectraChem brochure (First Hampton Decl., Exhibit I) fails to describe steps being performed with sufficient specificity so as to ascertain whether the SpectraChem service meets the requirements of the claimed invention, particularly the "calculating step" thereof. Accordingly, we agree with the Examiner that the SpectraChem brochure is insufficient corroborating evidence of a step of calculating of the amount of admixture (including both the injected fluid and tracer) recovered.

Patent Owner further argues that the term "calculating" was interpreted by the District Court for the Western District of Oklahoma to include both a mass balance approach and relative rate of recovery approach. According to Patent Owner, plotting returned tracer concentration over time,[15] as evidence by the Report cited by Mr. Hampton (Patent Owner's Comments of September 16, 2013, Exhibit G), is a calculation within the meaning of the term because it traces the relative rate of recovery. Reb. Br. 8–9.

The District Court determined that the term "calculating" means "determining by mathematical process" and that the phrase "calculating the amount . . . recovered" means "determining by mathematical process the amount . . . recovered." First Hampton Decl., Exhibit K, p. 13–14. The

[15] We note that this claim interpretation does not affect the Examiner's prima facie case of obviousness because the Examiner relies on Dean's teaching of using tracer data for "mass balance purposes," which Patent Owner seems to agree involves "calculating" even under a narrow interpretation.

District Court acknowledged that Patent Owner argues that "calculating" encompasses both the mass balance approach and the relative rate of recovery approach and that Defendants "disagree with Core's position that simply plotting tracer concentration over time satisfies the calculation step of the relative rate of recovery approach. *Id.* However, the District Court did not clearly reject either the Patent Owner or the Defendant's contentions or apply the definition in the *Markman* order so as to determine whether plotting tracer concentration over time constitutes "determining by mathematical process" an amount of injected material that is recovered. *Id.* Accordingly, we are not persuaded that the District Court necessarily "rejected Respondent's proposal, adopting instead Appellant's proposal," as argued by Patent Owner (Reb. Br. 9), since both parties included a "mathematical" element in their proposed definitions, which is all the District Court expressly adopted. *Id.*

As noted by Patent Owner, the Board is not bound by the District Court's claim interpretation because, unlike District Court, the Board operates under a broadest reasonable interpretation standard. *See In re Am. Acad. of Sci. Tech. Ctr.*, 367 F.3d 1359, 1364 (Fed. Cir. 2004) (claims . . . are to be given their broadest reasonable interpretation consistent with the specification, and . . . claim language should be read in light of the specification as it would be interpreted by one of ordinary skill in the art.") (*quoting In re Bond,* 910 F.2d 831, 833 (Fed. Cir. 1990)).

The '175 Patent does not expressly define the word "calculating." However, the Specification states:

> In the practice of the present invention, the recovered materials are tested for tracer concentration and the amount of

> material recovered determined. At this point, the well operator can make an informed decision regarding whether to continue clean up or begin production.
>
> The extent of recovery of materials injected including a tracer of the present invention is preferably determined by using a mass balance approach. Therein, the total amount of tracer admixed with the injected material is a known. [sic] A homogenous sample of production fluid is tested for tracer concentration and the amount of tracer recovered is thereby determined. The amount of injected admixture recovered is then determined using the formula:
>
> $$AMT_r=((T_r/T_i)xAMT_i)$$
>
> wherein AMT_r is the amount of injected admixture recovered, T_i is the amount of tracer injected; T_r is the amount of tracer recovered; and AMT_i is the amount of materials injected. T_r is determined by multiplying the concentrations of the tracer in the production fluid by the total quantity of production fluid recovered.
>
> Where a mass balance approach is not possible or desirable, a relative rate of recovery can also be determined by measuring the concentration of tracer in the production fluids recovered from an oil well as a function of time. In a process such as this, samples of production fluid being recovered from the well are taken, analyzed for tracer concentration that is then plotted against time and/or flow rates. This can also be a desirable way for an operator to decide when to begin production from an oil well.

’175 Patent, col. 5, ll. 23–52. In the Example, the ’175 Patent states that “[t]he flow back is tested for the presence and relative concentration of each tracer using a GC-mass spectrometer.” *Id.*, col. 7, ll. 19–21.

The language of the claim recites “calculating the amount of admixture recovered.” The ’175 Patent explains that by determining the

amount of material recovered, "the well operator can make an informed decision regarding whether to continue clean up or begin production." *Id.*, col. 5, ll. 23–26. The '175 Patent exemplifies determining the "amount of admixture recovered" or "extent of recovery of materials injected" only by using a mass balance approach. The '175 Patent explains that the relative rate of recovery "can *also* be a desirable way for an operator to decide when to begin production from an oil well." *Id.*, col. 5, ll. 51–52. (emphasis added.)

While the '175 Patent indicates that determining the amount of material recovered and determining the relative rate of recovery are both useful in determining when to begin production from an oil well, the '175 Patent does not reasonably support a finding that an amount of admixture recovered can be determined by plotting the concentration of tracer in the production fluids recovered from an oil well as a function of time. According to the '175 Patent, plotting concentration over time only determines "a relative rate of recovery" and not the amount of material recovered. Accordingly, we are not persuaded that a service that provides only plotting tracer concentration as a function of time includes the step of using the tracer concentration for calculating the amount of admixture recovered.

Since tracer concentration data over time (either per stage or total concentration) is all that was provided in the Report cited by Mr. Hampton (*see* Patent Owner's Response to the Action Closing Prosecution of September 16, 2013, Exhibits A, F, and G), the evidence is insufficient to

corroborate Mr. Hampton's testimony that a step of calculating the amount of admixture recovered was performed by ProTechnics.

Accordingly, Patent Owner has not met the burden of establishing that the evidence related to a long felt need met by, commercial success of, industry praise for, and copying of ProTechnics' SpectraChem services is relevant because it has failed to establish a nexus by preponderance of the evidence between ProTechnics' SpectraChem services and the claimed invention. In particular, Patent Owner has failed to establish by preponderance of the evidence that ProTechnics' SpectraChem services includes a step of "calculating the amount of admixture recovered from the oil well using the concentration of the chemical tracer present in the production fluid as a basis for the calculation."

Considering the evidence as a whole, we affirm the Examiner's rejection of claims 1, 5, and 6 under 35 U.S.C. § 103(a) as unpatentable over Hinkel and Deans.

B. Hinkel, Deans, and Dugstad (Ground II, RAN 7–10)

Claims 2–4, 9, and 11

The Examiner relies on Dugstad as evidence that the specific tracers recited in claims 2–4 and 11 were known in the art, namely fluorinated benzoic acid. The Examiner notes that Dugstad identifies fluorinated benzoic acids as tracers with a good recovery rate in water. *See* RAN 8 and 10 (citing Dugstad, p. 2). The Examiner also relies on Dugstad as teaching "the same mass balance approach as described in the '175 patent and in

claim 9 to calculate the ratio of the amount of injected fluid recovered based on the tracer concentration profile."

We agree with the Examiner that it would have been obvious to use the specific tracers recited in Dugstad in the tracer study taught by Deans. To do so would have been no more than the predictable use of a known tracer according to its established function as tracer material injected into an oil well. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 417 (2007) (The question to be asked is "whether the improvement is more than the predictable use of prior art elements according to their established functions."). Moreover, Deans teaches that

> The trace chemicals suitable for use in one embodiment of this invention can be selected from a wide category of known and available substances. In making such a selection the purpose of the trace chemical and the particular manner in which it is to be used should, or [sic] course, be kept in mind.

Deans, col. 7, ll. 11–16. In other words, the skilled artisan would have been capable of selecting a preferred tracer from known tracer chemicals for a particular purpose. *See Pfizer, Inc. v. Apotex, Inc.*, 480 F.3d 1348, 1368 (Fed. Cir. 2007) ("The fact that [the salt recited in the claim] was the best of the seven [] salts actually tested proves nothing more than routine optimization that would have been obvious to one of ordinary skill in the art.") (citing *In re* Aller, 220 F.2d 454, 456 (C.C.P.A. 1955) ("[E]ven though applicant's modification results in great improvement and utility over the prior art, it may still not be patentable if the modification was within the capabilities of one skilled in the art.")); *In re Swain*, 156 F.2d 246, 247–48 (C.C.P.A. 1946) ("In the absence of a proper showing of an unexpected and

superior result over the disclosure of the prior art, no invention is involved in a result obtained by experimentation.”).

Likewise, it would have been obvious to use the particular mass balance formula recited in Dugstad as the method of determining the amount of admixture recovered because Deans states that such a determination could be made using “general engineering principles.” *Id.*, col. 6, ll. 28–33. In other words, the skilled artisan would have been aware of the mass balance principles of Dugstad, as they are general engineering principles.

Patent Owner contends that a person of ordinary skill in the art would not have found it obvious to combine Dugstad with the teachings of Hinkel and Deans because Dugstad teaches a substantially different application from hydraulic fracturing operations and because the tracer study in Dugstad is substantially different and for a different purpose than the tracer study of the ’175 Patent. App. Br. 24; Second Wooley Decl. ¶ 17(c).

Patent Owner’s arguments are not persuasive for the same reasons discussed above with respect to the combination of Hinkel and Deans. Dugstad is relied upon for the purpose of showing that certain tracers were known for use in combination with fluid injected into an oil well. While we understand that the conditions and studies are different in Hinkel and Dugstad, merely pointing out the differences is insufficient in light of the Examiner’s reasoning. *See* Second Wooley Decl. ¶ 17(c). Patent Owner has provided no persuasive reasoning or evidence that the skilled artisan would not have expected the tracer of Dugstad to function similarly as a successful tracer in the hydraulic fracturing operation described in Hinkel. Similarly, Patent Owner has provided no persuasive reasoning or evidence that the

skilled artisan would not have expected to be able to use the mass balance equation cited in Dugstad as the general engineering principle for determining the amount of admixture recovered as described in Deans.

Considering the evidence as a whole, we affirm the Examiner's rejection of claims 2-4, 9, and 11 under 35 U.S.C. § 103(a) as unpatentable over Hinkel, Deans, and Dugstad.

C. Hinkel, Deans, and Chen (Ground III, RAN 10–11)

Claims 5-7

The Examiner relies on Chen as evidence that the use of tracers in the concentrations recited in claims 5–7 were known in the art. The Examiner found that Chen shows successful tracer determination at concentrations as low as 3ppm for water-soluble alkali metal salts of inorganic or organic compounds having fluorine in the anion by ^{19}FNMR spectroscopy. Chen, col 1, ll. 39–50 and col. 2, ll. 53–55. According to the Examiner, "it would have been obvious to one of ordinary skill in the art to use sufficiently small amount of the tracer compounds, as suggested by Chen, in the injected fluids disclosed in Hinkel and Deans in order to lower the operation cost and also reduce the negative effects that the tracers cause to the environment." *See* RAN 11.

We agree with the Examiner that it would have been obvious to one of ordinary skill in the art at the time of the invention to use the very low tracer concentration recited in Chen in a tracer study for an economical benefit, as taught by Chen. The Examiner found that Deans teaches that the concentration of trace chemicals in the injected fluid can be established by

one of ordinary skill in the art using general engineering principles and Deans, like Chen, encourages the use of small amounts of tracer chemicals "as a matter of economics." RAN 10–11; Deans, col. 7, ll. 30–35. Accordingly, it is within the skill of the ordinary artisan to select from known tracers those that can be detected in small quantities for their economic benefits.

Patent Owner contends that a person of ordinary skill in the art would not have found it obvious to combine Chen with the teachings of Hinkel and Deans because Chen teaches a substantially different application from hydraulic fracturing operations, and because the tracer study in Chen is substantially different and for a different purpose than the tracer study of the '175 Patent. App. Br. 24–25; Second Wooley Decl. ¶ 17(d).

Patent Owner's arguments are not persuasive for the same reasons discussed above with respect to the combination of Hinkel and Deans. Chen is relied upon for the purpose of showing that certain very low tracer concentrations can be detected after injected into an oil well admixed with a fluid. While we understand that the conditions and studies are different in Hinkel and Chen, merely pointing out the differences is insufficient in light of the Examiner's reasoning. *See* Second Wooley Decl. ¶ 17(d). Patent Owner has provided no persuasive reasoning or evidence that the skilled artisan would not have expected the tracer of Chen to function successfully in similarly low concentrations in the hydraulic fracturing operation described in Hinkel.

Considering the evidence as a whole, we affirm the Examiner's rejection of claims 5-7 under 35 U.S.C. § 103(a) as unpatentable over Hinkel, Deans, and Chen.

V. REMAINING REJECTIONS

Because our decision is dispositive regarding the unpatentability of all the claims, we need not reach the merits of the cumulative obviousness rejections based on other references. *See In re Gleave*, 560 F.3d 1331, 1338 (Fed. Cir. 2009) (holding that obviousness rejections need not be reached upon affirming a rejection of all claims as anticipated); *cf. Beloit Corp. v. Valmet Oy*, 742 F.2d 1421, 1423 (Fed. Cir. 1984) (having decided a single dispositive issue, the ITC was not required to review other matters decided by the presiding officer).

V. CONCLUSION

On the record before us and for the reasons presented above, we affirm the following rejections.

I. The Rejection of claims 1 and 5–6 under 35 U.S.C. § 103(a) as obvious in view of Hinkel in view of Deans;

II. The Rejection of claims 2–4, 9, and 11 under 35 U.S.C. § 103(a) as obvious over Hinkel and Deans and further in view of Dugstad; and

III. The Rejection of claims 5–7 under 35 U.S.C. § 103(a) as obvious over Hinkel and Deans in view of Chen.

Since we affirm rejections of each claim on appeal, we decline to address the merits of additional grounds of rejection maintained by the Examiner and appealed by the Patent Owner.

In the event neither party files a request for rehearing within the time provided in 37 C.F.R. § 41.79, and this decision becomes final and appealable under 37 C.F.R. § 41.81, a party seeking judicial review must timely serve notice on the Director of the United States Patent and Trademark Office. *See* 37 C.F.R. §§ 90.1 and 1.983.

AFFIRMED

ack

FOR PATENT OWNER:

MOSSMAN, KUMAR & TYLER PC
P.O. BOX 421239
HOUSTON, TX 77242

FOR THIRD-PARTY REQUESTER:

FELLERS SNIDER BLANKENSHIP BAILEY & TIPPENS
THE KENNEDY BUILDING
321 SOUTH BOSTON, SUITE 800
TULSA, OK 74103-3318

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
95/002,144	09/06/2012	7,032,662 B2	COR-1026-USCP-RE	4954

87627 7590 03/24/2015
Mossman, Kumar & Tyler PC
P.O. Box 421239
Houston, TX 77242

EXAMINER	
XU, LING X	

ART UNIT	PAPER NUMBER
3991	

MAIL DATE	DELIVERY MODE
03/24/2015	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

PTOL-90A (Rev. 04/07)

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SPECTRUM TRACER SERVICES, LLC.
Requester

v.

CORE LABORATORIES LP
Patent Owner and Appellant

Appeal 2015-001257
Reexamination Control 95/002,144
Patent 7,032,662 B2
Technology Center 3900

Before CHUNG K. PAK, JEFFREY B. ROBERTSON, and RAE LYNN P. GUEST, *Administrative Patent Judges*.

GUEST, *Administrative Patent Judge*.

DECISION ON APPEAL

I. STATEMENT OF CASE

This is a decision on appeal by Core Laboratories LP (hereinafter "Patent Owner")[1] from the Patent Examiner's decision to reject pending claims 1-7, 9, 10, and 13-21 in an *inter partes* reexamination of U.S. Patent 7,032,662 B2 (hereinafter, "the '662 Patent"). The Board's jurisdiction for this appeal is under 35 U.S.C. §§ 6(b), 134(b), and 315(a).

The '662 patent is related to U.S. Patent 6,659,175 B2 ("the '175 Patent"), which is the subject of Reexamination Control 95/002,141, also currently on appeal. The '175 Patent and the '662 Patent are the subjects of a litigation in the U.S. District Court for the Western District of Oklahoma styled *Core Laboratories LP v. Spectrum Tracer Services, LLC*, Case No. 11-cv-1157-M. The litigation is stayed pending the outcome of these reexamination proceedings.

We concurrently heard oral arguments from Patent Owner and Requester concerning the reexaminations of the '175 Patent and '662 Patent on February 11, 2015, a written transcript of which will be entered into the electronic record in both cases in due course.

We AFFIRM.

II. BACKGROUND

The '662 Patent issued April 25, 2006, to Scott Malone et al. A request for *inter partes* reexamination under 35 U.S.C. §§ 311–318 and 37 C.F.R. §§ 1.902–1.997 for the '175 Patent was filed September 6, 2012 by a Third-Party Requester, Spectrum Tracer Services, LLC, (hereinafter

[1] *See* Patent Owner's Supplemental Appeal Brief, filed June 13, 2014 ("App. Br.") 2.

"Requester"). Request for *Inter Partes* Reexamination 1; Requester's Respondent Brief, filed May 23, 2014 (hereinafter "Res. Br.") 1.

Claims 1–21 were original to the '662 patent. Claims 11 and 12 were not subject to reexamination, and claim 8 was cancelled during this proceeding. Claims 1–7, 9, 10 and 13–21 stand rejected and are currently appealed. Right of Appeal Notice mailed February 7, 2014 (hereinafter "RAN") 1; App. Br. 3.

The '662 Patent relates to a method for determining the extent of recovery of materials injected into an oil well during oil and gas exploration and 4production using chemical tracers. '662 Patent, col. 1, ll. 19–25.

Claims 1 and 14 are representative of the claims on appeal and reads as follows, (with underlining showing language added during reexamination and indentations added for clarity).

> 1. A method for determining the extent of recovery of materials injected into an oil well comprising:
>
> a) admixing a material to be injected into an oil well with a chemical tracer compound at a predetermined concentration<u>, wherein the material injected into the oil well is a hydraulic fracturing fluid</u>;
>
> b) injecting the admixture into an oil well or an offset well associated with an oil well;
>
> c) recovering from the oil well a production fluid;
>
> d) analyzing the production fluid for a concentration of the chemical tracer present in the production fluid; and
>
> e) calculating the amount of admixture recovered from the oil well using the concentration of the chemical tracer present in the production fluid as a basis for the calculation.
>
> 14. A method for determining the extent of recovery of a material of interest injected into an oil well or a subsurface formation associated with a bore of the oil well comprising:

> a) introducing a material of interest into the oil well or into the subsurface formation associated with the bore of the oil well, wherein the material of interest injected into the oil well is a material useful for hydraulically fracturing the oil well;
>
> b) introducing a tracer into the oil well or into the subsurface formation associated with the bore of the oil well;
>
> c) recovering from the oil well a production fluid;
>
> d) analyzing the production fluid for a concentration of the chemical tracer present in the production fluid; and
>
> e) calculating the amount of material of interest recovered from the oil well using the concentration of the chemical tracer present in the production fluid as a basis for the calculation.

App. Br. 8–9[2] and Claims App'x; RAN 4. The Examiner maintains the following rejections on appeal. *See* App. Br. 6–7.

I. The Rejection of claims 1, 5, 6, 9, 14, 17 and 19 under 35 U.S.C. § 103(a) as obvious in view of Hinkel[3] in view of Deans.[4] *See* Ground I, RAN 5–8.

II. The Rejection of claims 1, 5, 6, 9, 13, 14, 17 and 19 under 35 U.S.C. § 103(a) as obvious in view of Hinkel in view of Hall.[5] *See* Ground IX, RAN 20–22.

---

[2] On page 8 of Patent Owner's Appeal Brief, Patent Owner states that the language added to claim 1 reads "wherein the material injected into the oil well is a material useful for hydraulically fracturing the oil well." However, this statement is inconsistent with the amendment of record (*see* Patent Owner Response, dated January 22, 2013, 2; *see also* RAN 4) and with Patent Owner's statement that "[t]he newly-added limitation was originally present in dependent Claim 8. *See* '662 Patent at 9:64–65." App. Br. 9.

[3] US 6,192,985 B1, issued Feb. 27, 2001, to Hinkel et al.

[4] US 4,090,398, issued May 23, 1978, to Deans et al.

[5] EP 0 282 232 A2, published Sep. 14, 1988, listing Christopher Hall as inventor.

III. The Rejection of claims 2–4, 10, and 15–21 under 35 U.S.C. § 103(a) as obvious over Hinkel and Deans and further in view of Dugstad.[6] *See* Ground II, RAN 8–10.

IV. The Rejection of claims 2–4, 10, and 15–17 and 19–21 under 35 U.S.C. § 103(a) as obvious over Hinkel and Hall and further in view of Dugstad. *See* Ground X, RAN 22–24.

V. The Rejection of claims 5–7 under 35 U.S.C. § 103(a) as obvious over Hinkel and Deans and further in view of Chen,[7] Hoots,[8] or Greenkorn[9] or Hinkel and Hall and further in view of Chen or Hoots. *See* Grounds III, IV, VI, XI, and XII, RAN 11–13, 15–16, and 24–27.

VI. The Rejection of claims 5 and 6 under 35 U.S.C. § 103(a) as obvious over Hinkel and Deans and further in view of Teasdale.[10] *See* Ground V, RAN 14–15.

VII. The Rejection of claims 2–4 and 15–20 under 35 U.S.C. § 103(a) as obvious over Hinkel, Deans, and Teasdale or Greenkorn, and further in view of Bowman.[11] *See* Grounds VII, VIII, RAN 16–20.

---

[6] Dugstad, et al., "Application of Tracers to Monitor Fluid Flow in the Snorre Field: A Field Study," Society of Petroleum Engineers, Publication No. SPE 56427 (1999).
[7] US 4,303,411, issued Dec. 1, 1981 to Chen et al.
[8] US 4,783,314, issued Nov. 8, 1988 to Hoots et al.
[9] Greenkorn, Robert A., "Experimental Study of Waterflood Tracers," Society of Petroleum Engineers, Publication No. SPE 169 (January 1962).
[10] US 4,223,725, issued Sep. 23, 1980 to Teasdale et al.
[11] Bowman, R.S., "Evaluation of Some New Tracers for Soil Water Studies," Soil Sci. Soc. Am. J. 48:987–993 (1984).

VIII. The Rejection of claims 2–4, 15–17, and 19 under 35 U.S.C. § 103(a) as obvious over Hinkel and Hall, further in view of Bowman. *See* Ground XIII, RAN 27–28.

IX. The Rejection of claim 13 under 35 U.S.C. § 103(a) as obvious over Hinkel, Deans and Hall. *See* Ground XIV, RAN 29–30.

Patent Owner relies on the testimony of J. Thomas Hampton. *See* Rule 132 Technical Declaration of J. Thomas Hampton, dated January 15, 2013 (hereinafter the "First Hampton Declaration") (App. Br. 14); Rule 132 Technical Declaration of J. Thomas Hampton, dated September 1, 2013 (hereinafter the "Supplemental Hampton Declaration") (App. Br. 10).[12] Patent Owner also relies on the testimony of Dr. Gary Wooley. *See* Rule 132 Technical Declaration of Gary Wooley, dated January 15, 2013 (hereinafter the "First Wooley Declaration"); Rule 132 Supplemental Technical

---

[12] With the Appeal Brief filed June 13, 2014, Patent Owner submitted a "Rule 132 Technical Declaration of J. Thomas Hampton," dated January 15, 2013 as the "First Hampton Declaration," which includes no exhibits, and a second "Rule 132 Technical Declaration of J. Thomas Hampton," which is also dated January 15, 2013, as the "Second Hampton Declaration," which includes Exhibits A–K. It is clear from the record that Patent Owner intended to submit the "Second Hampton Declaration," dated January 15, 2013 as the "First Hampton Declaration" because of the citations in the Appeal Brief to Exhibits A–K of the "First Hampton Declaration." It is also clear from the record that Patent Owner intended to submit an entirely different declaration as the "Second Hampton Declaration," namely, the "Rule 132 Supplemental Technical Declaration of J. Thomas Hampton" that was executed on September 1, 2013, and made of record on September 16, 2013. The error is apparent because Patent Owner specifically identifies the separate declarations by execution date (*see* App. Br. 10 and 14) and refers to paragraph numbers and Exhibits consistent therewith.

Declaration of Gary Wooley, dated September 16, 2013 (hereinafter the "Second Wooley Declaration) (App. Br. 10). Patent Owner also relies on the testimony of Mr. Michael J. Flecker, dated September 16, 2013 (referred to by Patent Owner as the "Flecker Declaration") (App. Br. 17).

Requester relies on the testimony of Alfred Roy Jennings, Jr. *See* Declaration of Alfred Roy Jennings, Jr., P.E., dated February 20, 2013 (hereinafter "First Jennings Declaration") (Res. Br. 5); Supplemental Declaration of Alfred Roy Jennings, Jr., P.E., dated October 3, 2013 (hereinafter "Supplemental Jennings Declaration") (Res. Br. 9).

A. Hinkel and Deans (Ground I, RAN 5–7)

Claims 1, 5, 6, 9, 14, 17 and 19

The dispositive issue on appeal is:

Does a preponderance of the evidence support Patent Owner's contention that the Examiner erred in determining that it would have been obvious for one of ordinary skill in the art to use tracer data to determine the extent of recovered material that has been injected into an oil well, as taught by Deans, in a hydraulic fracturing operation in which recovery of all of the injected fracturing fluid is necessary for optimum hydrocarbon recovery, as described in Hinkel? We answer this question in the negative.

Patent Owner initially argues that the Examiner erred in interpreting the language added during reexamination to claim 1, namely "wherein the material injected into the oil well is a hydraulic fracturing fluid," and to claim 14, namely "the material injected into the oil well is a material useful for hydraulically fracturing the oil well." According to Patent Owner, this

language, read in light of the disclosure of the ’662 Patent, indicates that the claim is limited to a method of determining the extent of recovery of hydraulic fracturing fluid in a hydraulic fracturing operation. App. Br. 8–18. The Examiner determined that the claim is not limited to a hydraulic fracturing operation. RAN 4–5 and 32; Res. Br. 2–3.

Even assuming that the claim is limited to hydraulic fracturing, Hinkel discloses an admixture of a hydraulic fracturing fluid and a tracer used in a hydraulic fracturing operation. *See* RAN 5–6 (“Hinkel further discloses that tracers can be added to the various fracturing fluid stages in actual field applications so that a tracer study can be performed to verify the effectiveness of the fracture clean–up process (see Example 4).”); Res. Br. 8 (“Hinkel teaches the use of a tracer study in a staged fracturing operation and provides clear and repeated motivation for determining the amount of fracturing fluid recovered.”). Hinkel teaches admixing a tracer and a hydraulic fracturing fluid. Col. 3, ll. 9-19; Ex. 4.

Patent Owner contends that one of ordinary skill in the art would not have looked to the tracer study of Deans, which teaches the steps of (e) analyzing the production fluid for the concentration of the chemical tracer and (f) calculating the amount of admixture recovered from the oil well using the concentration of the chemical tracer, for use in the hydraulic fracturing operation of Hinkel. App. Br. 21–22. Patent Owner argues that one of ordinary skill in the art would have no reason to look to Deans because (a) Deans’ water flooding operation is non-analogous art to Hinkel’s hydraulic fracturing operation, (b) Deans’ tracer study is for a different purpose than Hinkel’s tracer study, and (c) Deans teaches away from a

hydraulic fracturing operation. App. Br. 20–23. Thus, Patent Owner argues that hydraulic fracturing and water flooding operations are not in the same field of endeavor. App. Br. 22–23. Dr. Wooley explains the differences between these two operations. Wooley First Decl. ¶ 12–14; *see also* Wooley Second Decl. ¶ 15, 19, and 20. Nonetheless, Dr. Wooley admits that "it is true that both operations require the injection of materials into an oil well," Wooley Second Decl. ¶ 19.

Whether a prior art reference is "analogous" is a question of fact. *In re Clay*, 966 F.2d 656, 658 (Fed. Cir. 1992). "The analogous-art test requires that the Board show that a reference is either in the field of the applicant's endeavor or is reasonably pertinent to the problem with which the inventor was concerned in order to rely on that reference as a basis for rejection." *In re Kahn*, 441 F.3d 977, 986–987 (Fed. Cir. 2006) (citing *In re Oetiker*, 977 F.2d 1443, 1447 (Fed. Cir. 1992)). "The rationale behind this rule precluding rejections based on combination of teachings of references from nonanalogous arts is the realization that an inventor could not possibly be aware of every teaching in every art. Thus, we attempt to more closely approximate the reality of the circumstances surrounding the making of an invention by only presuming knowledge by the inventor of prior art in the field of his endeavor and in analogous arts." *In re Wood*, 599 F.2d 1032, 1036 (CCPA 1979). The question is not whether the combined art is analogous to each other, but whether the combined references are each analogous to the "applicant's endeavor." *Id.*

We are not persuaded that the field of endeavor of the '662 Patent is limited to hydraulic fracturing. Rather, the inventor's field of endeavor is

determined by the disclosure of the ’662 Patent. *See Wood*, 599 F.2d at 1036. The ’662 Patent is not limited to hydraulic fracturing, but rather is related to any operation in which materials injected into an oil well during oil and gas exploration and production are recovered. *See* ’662 Patent, col. 1, ll. 19–25 and col. 1, l. 46 to col. 2, l. 2. Both water flooding and hydraulic fracturing operations require recovery of material injected into an oil well and both are operations that occur during oil and gas exploration and production.

Even if the field of endeavor is properly limited to determining amount of fracturing fluid recovered from a hydraulic fracturing operation, as argued by Patent Owner, both Hinkel and Deans are reasonably pertinent to the problem with which the inventor was concerned. “A reference is reasonably pertinent if ... it is one which, because of the matter with which it deals, logically would have commended itself to an inventor's attention in considering his problem. If a reference disclosure has the same purpose as the claimed invention, the reference relates to the same problem, and that fact supports use of that reference in an obviousness rejection.” *Innovention Toys, LLC v. MGA Entm’t, Inc.*, 637 F.3d 1314, 1321 (Fed. Cir. 2011) (quoting *Clay*, 966 F.2d at 659); *see also In re Klein*, 647 F.3d 1343, 1348 (Fed. Cir. 2011). “References are selected as being reasonably pertinent to the problem based on the judgment of a person having ordinary skill in the art.” *Kahn*, 441 F.3d at 986-987.

Hinkel would have been reasonably pertinent because it relates to recovery of fracturing material in a hydraulic fracturing process and using tracer studies to evaluate the effectiveness of the recovery. Patent Owner

argues that Deans is not related to determining the amount of fluid recovered, but rather to determining the fluid saturations of immobile fluid phase and a mobile fluid phase in a subterranean reservoir. Reb. Br. 12. However, Deans teaches that not only can return tracer concentrations be used to determine "the dissolved immobile fluid concentration," but that the return tracer concentration can also be used to determine "when the total volume of fluid injected into the formation has been produced." Deans, col. 6, ll. 22–28. According to Deans, "knowledge of when the volume of injected fluid has been produced can be determined either by knowing the total injected fluid volume or by measuring the tracer concentration profile in the produced fluid and determining the injected fluid volume using general engineering principles." *Id.* at ll. 28–33. Thus, Deans would also be reasonably pertinent since it teaches a method to determine the extent of recovery of a fluid injected into an oil well, i.e. the volume of fluid injected into the formation that has been produced, using recovered tracer concentrations, which is the same purpose of the tracer as in the claimed invention. Accordingly both Hinkel and Deans are analogous art to the present invention.

Therefore, we turn to the question of whether it would have been obvious to a skilled artisan to use the recovery evaluation procedure of Deans to determine the full extent of recovery of the hydraulic fracturing fluid in the hydraulic fracturing operation of Hinkel.

Patent Owner argues that the purpose of the tracer in Hinkel is different than the purpose of the tracer in Deans, and that the processes are too different for the skilled artisan to expect success in using the tracer study

of Deans in a hydraulic fracturing operation such as Hinkel. App. Br. 22–23.

The Examiner stated that it would have been obvious to use the tracer study of Deans in the hydraulic fracturing operation of Hinkel "in order to determine the effectiveness of the fracture clean-up process disclosed in Hinkel." RAN 7-8. Hinkel explains the importance of deliberately removing the fracturing fluid from the fracture, i.e. "clean-up," for example, to avoid the presence of fluid acting as a barrier to the migration of hydrocarbon from the formation. Hinkel, col. 2, l. 44 to col. 3, l. 38. While the diagnostics discussed in Hinkel are directed to the improvement in removing fluid retained in the distal-most portion of the fracture from the wellbore (*id.*), the Examiner is relying on the diagnostics of Deans not the diagnostics of Hinkel. RAN 7–8. Hinkel nonetheless teaches the importance of ensuring maximum recovery of injected hydraulic fracturing material. Accordingly, we agree with the Examiner that Hinkel provides sufficient reason for the skilled artisan to evaluate the extent of admixture recovered.

Patent Owner has not persuasively demonstrated by a preponderance of the evidence that the tracer study of Deans would be either incapable of working or not expected to work in the hydraulic fracturing operation of Hinkel. Since Hinkel uses known tracers in hydraulic fracturing operations, one of ordinary skill in the art would have expected that the extent of recovery could be determined using tracer measurements and material balances described in Deans.

Finally, Patent Owner argues that Deans "teaches away" from a hydraulic fracturing operation by requiring an injection rate of the brine material that is low enough to avoid fracturing the formation. App. Br. 21–22; *see* Deans, col. 7, ll. 42–43. A reference "teaches away" when it suggests that the developments flowing from its disclosures are unlikely to produce the objective of the Appellants' invention. *See In re Gurley,* 27 F.3d 551, 553, 31 USPQ2d 1130, 1131–32 (Fed. Cir. 1994). Additionally, a reference may "teach away" from a use when that use would render the result inoperable. *McGinley v. Franklin Sports, Inc.*, 262 F.3d 1339, 1354 (Fed. Cir. 2001) ("If references taken in combination would produce a "seemingly inoperative device," we have held that such references teach away from the combination and thus cannot serve as predicates for a prima facie case of obviousness.").

Patent Owner's argument that Deans teaches away from the claimed invention is directed to the injection rate of brine in Deans, while the rejection of record is directed to the hydraulic fracturing operation of Hinkel. Dr. Wooley discusses the difference between the injection processes of Hinkel and Deans. Wooley First Decl. ¶ 12–15. However, any difference in the injection rate of the brine material in the method for determining fluid saturation of Deans does not amount to a teaching away from applying the tracer study of Deans to the rejection or to the fracturing process of Hinkel.[13]

[13] Nonetheless, Deans' teaching that the injection rate should not be so high that the formation will fracture (Deans, col. 7, ll. 42–43) is evidence that brine materials might be substituted for other known fracturing fluids in a fracturing operation provided that the brine material is injected at a high enough flow rate.

As discussed above, Patent Owner has directed us to no persuasive evidence that the tracer study evaluations of Deans would not be reasonably expected to work in the hydraulic fracturing operation of Hinkel or would somehow make the hydraulic fracturing operation inoperable. In fact, the evidence as a whole supports otherwise because Hinkel clearly discloses tracer materials successfully used and recovered during hydraulic fracturing operations. Therefore, we are not persuaded that one of ordinary skill in the art would be dissuaded from applying the tracer study of Deans to the hydraulic fracturing operation disclosed in Hinkel.

Secondary Considerations of Non-obviousness

Patent Owner relies on the First and Second declarations of Mr. J. Thomas Hampton, the declaration of Mr. Michael J. Flecker, and the Second Declaration of Dr. Wooley as evidence of non-obviousness based on secondary consideration, namely that ProTechnics' SpectraChem service satisfied a long felt but unmet need in the art, was copied, received industry praise, and was commercially successful. App. Br. 15–19.

For objective evidence to be accorded substantial weight, Patent owner must establish a nexus between the evidence and the merits of the claimed invention. *In re GPAC*, 57 F.3d 1573, 1580 (Fed. Cir. 1995) (appellant offers no evidence that the market reaction to appellants' invention is rooted in the subject matter claimed). Put another way, commercial success or other secondary considerations may presumptively be attributed to the claimed invention only where "the marketed product embodies the claimed features, and is coextensive with them." *Ormco Corp.*

v. Align Tech. Inc., 463 F.3d 1299, 1311–12 (Fed. Cir. 2006) (*quoting Brown & Williamson Tobacco Corp. v. Phillip Morris, Inc.,* 229 F.3d 1120, 1130 (Fed. Cir. 2000)).

The Examiner found that there was insufficient evidence to find a nexus between the SpectraChem service offered by ProTechnics and the claimed method for the evidence to having meaningful weight in an obviousness analysis. *See* RAN 44. In particular, the Examiner determined that the evidence did not support a finding that the SpectraChem service included the step of "calculating the amount of admixture recovered from the oil well using the concentration of the chemical tracer present in the production fluid as a basis for the calculation." *See* RAN 75.

Mr. Hampton testifies that the SpectraChem service provided by ProTechnics corresponds to the subject matter of Amended Claims 1 and 8. *See* First Hampton Decl. ¶ 11.[14] To corroborate this testimony, Mr. Hampton points to Exhibit H, which is a claim chart prepared by Mr. Hampton, and Exhibit I, which is a brochure of ProTechnics' services. In Exhibit H, Mr. Hampton states

> The attached brochure verifies that Step f) is performed.
>
> SPECTRACHEM tracers are routinely used to quantify and profile frac fluid clean-up and flowback efficiency over time.
>
> ProTechnics performs this step by either using a mass balance approach or a relative rate of recovery.

[14] While Dr. Wooley and Mr. Flecker provide additional testimony of secondary considerations of non-obviousness, they provide no persuasive testimony regarding the nexus between ProTechnics' SpectraChem service and the claimed method.

First Hampton Decl., Exhibit H, p. 1–2. The second sentence is a quote from the fourth page of the brochure submitted as Exhibit I. Mr. Hampton then cites to a *Markman* ruling in a district court litigation involving the '662 Patent. Mr. Hampton further testifies that he had explained during a preliminary injunction hearing that ProTechnics performs step f) by either a mass balance approach or a relative rate of recovery approach and that "the tracer concentrations were used to determine the amounts of fluid that were flowing back." *See* Supplemental Hampton Decl. ¶ 20 (citing Exhibit A to the Declaration, 29, l. 1 to 32, l. 5).[15] Accordingly, Patent Owner is relying on the testimony of Mr. Hampton as an expert in the field. *See* App. Br. 17 ("The Examiner either discounted or ignored Mr. Hampton's declaration testimony that Appellant's services do include the 'calculating' step. *See, e.g.*, Second [Supplemental] Hampton Dec. ¶ 20 (testifying that 'the tracer concentrations were used to determine the amounts of fluid that were flowing back.')."

Although Mr. Hampton, as president of the ProTechnics division of Core Laboratories, would have personal knowledge of the services provided by ProTechnics, we decline to give substantial weight to the testimony of Mr. Hampton without corroborating evidence that ProTechnics performs the

[15] During the Preliminary Injunction Hearing, Mr. Hampton testified that the Report demonstrates tracer concentration recovery per stage of operation and total tracer concentration recovery. When asked "Can you explain how the relative rate of recovery satisfies the claim element of calculating the amount of admixture recovered?" Mr. Hampton points to where in the Report "we just add the amount of chemical coming back from each stage so that you can see the total amount of chemical tracer coming back on that particular job." Exhibit A, filed with Patent Owner's Response to the Action Closing Prosecution on September 16, 2013, 29, l. 1 to 32, l. 5.

additional step of calculating the amount of admixture recovered from the tracer concentration data. *See, e.g., Am. Acad. of Sci. Tech. Ctr.*, 367 F.3d at 1368 ("[T]he Board is entitled to weigh the declarations and conclude that the lack of factual corroboration warrants discounting the opinions expressed in the declarations."); *In re Etter*, 756 F.2d 852, 859–60 (Fed. Cir. 1985) (opinion affidavit asserting the reference disclosed obsolete technology was correctly characterized by the board "as merely representing opinion[] unsupported by facts and thus entitled to little or no weight") (citing *In re Piasecki*, 745 F.2d 1468, 1472–73 (Fed. Cir. 1984); *In re Rinehart*, 531 F.2d 1048, 1052 (CCPA 1976)).

The language of the SpectraChem brochure (First Hampton Decl., Exhibit I) fails to describe steps being performed with sufficient specificity so as to ascertain whether the SpectraChem service meets the requirements of the claimed invention, particularly the "calculating step" thereof. Accordingly, we agree with the Examiner that the SpectraChem brochure is insufficient corroborating evidence of a step of calculating of the amount of admixture (including both the injected fluid and tracer) recovered.

Patent Owner further argues that the term "calculating" was interpreted by the District Court for the Western District of Oklahoma to include both a mass balance approach and relative rate of recovery approach. According to Patent Owner, plotting returned tracer concentration over time,[16] as evidence by the Report cited by Mr. Hampton (Patent Owner's

[16] We note that this claim interpretation does not affect the Examiner's prima facie case of obviousness because the Examiner relies on Dean's teaching of using tracer data for "mass balance purposes," which Patent Owner seems to agree involves "calculating" even under a narrow interpretation.

Comments of September 16, 2013, Exhibit G), is a calculation within the meaning of the term because it traces the relative rate of recovery. Reb. Br. 8–9.

The District Court determined that the term "calculating" means "determining by mathematical process" and that the phrase "calculating the amount . . . recovered" means "determining by mathematical process the amount . . . recovered." First Hampton Decl., Exhibit K, p. 13–14. The District Court acknowledged that Patent Owner argues that "calculating" encompasses both the mass balance approach and the relative rate of recovery approach and that Defendants "disagree with Core's position that simply plotting tracer concentration over time satisfies the calculation step of the relative rate of recovery approach. *Id.* However, the District Court did not clearly reject either the Patent Owner or the Defendant's contentions or apply the definition in the *Markman* order so as to determine whether plotting tracer concentration over time constitutes "determining by mathematical process" an amount of injected material that is recovered. *Id.* Accordingly, we are not persuaded that the District Court necessarily "rejected Respondent's proposal, adopting instead Appellant's proposal," as argued by Patent Owner (Reb. Br. 9), since both parties included a "mathematical" element in their proposed definitions, which is all the District Court expressly adopted. *Id.*

As noted by Patent Owner, the Board is not bound by the District Court's claim interpretation because, unlike District Court, the Board operates under a broadest reasonable interpretation standard. *See In re Am. Acad. of Sci. Tech. Ctr.*, 367 F.3d 1359, 1364 (Fed. Cir. 2004) (claims . . .

are to be given their broadest reasonable interpretation consistent with the specification, and . . . claim language should be read in light of the specification as it would be interpreted by one of ordinary skill in the art.") (*quoting In re Bond,* 910 F.2d 831, 833 (Fed. Cir. 1990)).

The '662 Patent does not expressly define the word "calculating." However, the Specification states:

> In the practice of the present invention, the recovered materials are tested for tracer concentration and the amount of material recovered determined. At this point, the well operator can make an informed decision regarding whether to continue clean up or begin production.
>
> The extent of recovery of materials injected including a tracer of the present invention is preferably determined by using a mass balance approach. Therein, the total amount of tracer admixed with the injected material is a known. [sic] A homogenous sample of production fluid is tested for tracer concentration and the amount of tracer recovered is thereby determined. The amount of injected admixture recovered is then determined using the formula:
>
> $$AMT_r=((T_r/T_i)xAMT_i)$$
>
> wherein AMT_r is the amount of injected admixture recovered, T_i is the amount of tracer injected; T_r is the amount of tracer recovered; and AMT_i is the amount of materials injected. T_r is determined by multiplying the concentrations of the tracer in the production fluid by the total quantity of production fluid recovered.
>
> Where a mass balance approach is not possible or desirable, a relative rate of recovery can also be determined by measuring the concentration of tracer in the production fluids recovered from an oil well as a function of time. In a process such as this, samples of production fluid being recovered from the well are taken, analyzed for tracer concentration that is then

> plotted against time and/or flow rates. This can also be a desirable way for an operator to decide when to begin production from an oil well.

’662 Patent, col. 5, l. 52 to col. 6, l. 20. In the Example, the ’662 Patent states that “[t]he flow back is tested for the presence and relative concentration of each tracer using a GC-mass spectrometer.” *Id.*, col. 8, l. 66 to col. 9, l. 1.

The language of the claim recites “calculating the amount of admixture recovered.” The ’662 Patent explains that by determining the amount of material recovered, “the well operator can make an informed decision regarding whether to continue clean up or begin production.” *Id.*, col. 5, ll. 52–56. The ’662 Patent exemplifies determining the “amount of admixture recovered” or “extent of recovery of materials injected” only by using a mass balance approach. The ’662 Patent explains that the relative rate of recovery “can *also* be a desirable way for an operator to decide when to begin production from an oil well.” *Id.*, col. 6, ll. 11–20. (emphasis added.)

While the ’662 Patent indicates that determining the amount of material recovered and determining the relative rate of recovery are both useful in determining when to begin production from an oil well, the ’662 Patent does not reasonably support a finding that an amount of admixture recovered can be determined by plotting the concentration of tracer in the production fluids recovered from an oil well as a function of time. According to the ’662 Patent, plotting concentration over time only determines “a relative rate of recovery” and not the amount of material recovered. Accordingly, we are not persuaded that a service that provides

only plotting tracer concentration as a function of time includes the step of using the tracer concentration for calculating the amount of admixture recovered.

Since tracer concentration data over time (either per stage or total concentration) is all that was provided in the Report cited by Mr. Hampton (*see* Patent Owner's Response to the Action Closing Prosecution of September 16, 2013, Exhibits A, F, and G), the evidence is insufficient to corroborate Mr. Hampton's testimony that a step of calculating the amount of admixture recovered was performed by ProTechnics.

Accordingly, Patent Owner has not met the burden of establishing that the evidence related to a long felt need met by, commercial success of, industry praise for, and copying of ProTechnics' SpectraChem services is relevant because it has failed to establish a nexus by preponderance of the evidence between ProTechnics' SpectraChem services and the claimed invention. In particular, Patent Owner has failed to establish by preponderance of the evidence that ProTechnics' SpectraChem services includes a step of "calculating the amount of admixture recovered from the oil well using the concentration of the chemical tracer present in the production fluid as a basis for the calculation."

Considering the evidence as a whole, we affirm the Examiner's rejection of claims 1, 5, 6, 9, 14, 17 and 19 under 35 U.S.C. § 103(a) as unpatentable over Hinkel and Deans.

B. Hinkel, Deans, and Dugstad (Ground II, RAN 8–10)

Claims 2–4, 10, and 15–21

The Examiner relies on Dugstad as evidence that the specific tracers recited in claims 2–4 and 15 and 16 were known in the art, namely fluorinated benzoic acid. The Examiner notes that Dugstad identifies fluorinated benzoic acids as tracers with a good recovery rate in water. *See* RAN 9 and 10 (citing Dugstad, p. 2). The Examiner also relies on Dugstad as teaching "the same mass balance approach as described in the '662 patent and in claims 10 and 21 to calculate the ratio of the amount of injected fluid recovered based on the tracer concentration profile." *Id.* at 10.

We agree with the Examiner that it would have been obvious to use the specific tracers recited in Dugstad in the tracer study taught by Deans. To do so would have been no more than the predictable use of a known tracer according to its established function as tracer material injected into an oil well. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 417 (2007) (The question to be asked is "whether the improvement is more than the predictable use of prior art elements according to their established functions."). Moreover, Deans teaches that

> The trace chemicals suitable for use in one embodiment of this invention can be selected from a wide category of known and available substances. In making such a selection the purpose of the trace chemical and the particular manner in which it is to be used should, or [sic] course, be kept in mind.

Deans, col. 7, ll. 11–16. In other words, the skilled artisan would have been capable of selecting a preferred tracer from known tracer chemicals for a particular purpose. *See Pfizer, Inc. v. Apotex, Inc.*, 480 F.3d 1348, 1368

(Fed. Cir. 2007) ("The fact that [the salt recited in the claim] was the best of the seven [] salts actually tested proves nothing more than routine optimization that would have been obvious to one of ordinary skill in the art.") (citing *In re* Aller, 220 F.2d 454, 456 (C.C.P.A. 1955) ("[E]ven though applicant's modification results in great improvement and utility over the prior art, it may still not be patentable if the modification was within the capabilities of one skilled in the art.")); *In re Swain*, 156 F.2d 246, 247–48 (C.C.P.A. 1946) ("In the absence of a proper showing of an unexpected and superior result over the disclosure of the prior art, no invention is involved in a result obtained by experimentation.").

Likewise, it would have been obvious to use the particular mass balance formula recited in Dugstad as the method of determining the amount of admixture recovered because Deans states that such a determination could be made using "general engineering principles." *Id.*, col. 6, ll. 28–33. In other words, the skilled artisan would have been aware of the mass balance principles of Dugstad, as they are general engineering principles.

Patent Owner contends that a person of ordinary skill in the art would not have found it obvious to combine Dugstad with the teachings of Hinkel and Deans because Dugstad teaches a substantially different application from hydraulic fracturing operations and because the tracer study in Dugstad is substantially different and for a different purpose than the tracer study of the '662 Patent. App. Br. 23–24; Second Wooley Decl. ¶ 17(c).

Patent Owner's arguments are not persuasive for the same reasons discussed above with respect to the combination of Hinkel and Deans. Dugstad is relied upon for the purpose of showing that certain tracers were

known for use in combination with fluid injected into an oil well. While we understand that the conditions and studies are different in Hinkel and Dugstad, merely pointing out the differences is insufficient in light of the Examiner's reasoning. *See* Second Wooley Decl. ¶ 17(c). Patent Owner has provided no persuasive reasoning or evidence that the skilled artisan would not have expected the tracer of Dugstad to function similarly as a successful tracer in the hydraulic fracturing operation described in Hinkel. Similarly, Patent Owner has provided no persuasive reasoning or evidence that the skilled artisan would not have expected to be able to use the mass balance equation cited in Dugstad as the general engineering principle for determining the amount of admixture recovered as described in Deans.

Considering the evidence as a whole, we affirm the Examiner's rejection of claims 2–4, 10, and 15–21 under 35 U.S.C. § 103(a) as unpatentable over Hinkel, Deans, and Dugstad.

C. Hinkel, Deans, and Chen (Ground III, RAN 11–12)

Claims 5–7

The Examiner relies on Chen as evidence that the use of tracers in the concentrations recited in claims 5–7 were known in the art. The Examiner found that Chen shows successful tracer determination at concentrations as low as 3ppm for water-soluble alkali metal salts of inorganic or organic compounds having fluorine in the anion by ^{19}FNMR spectroscopy. Chen, col 1, ll. 39–50 and col. 2, ll. 53–55. According to the Examiner, "it would have been obvious to one of ordinary skill in the art to use sufficiently small amount of the tracer compounds, as suggested by Chen, in the injected fluids

disclosed in Hinkel and Deans in order to lower the operation cost and also reduce the negative effects that the tracers cause to the environment." *See* RAN 12.

We agree with the Examiner that it would have been obvious to one of ordinary skill in the art at the time of the invention to use the very low tracer concentration recited in Chen in a tracer study for an economical benefit, as taught by Chen. The Examiner found that Deans teaches that the concentration of trace chemicals in the injected fluid can be established by one of ordinary skill in the art using general engineering principles and Deans, like Chen, encourages the use of small amounts of tracer chemicals "as a matter of economics." RAN 11–12; Deans, col. 7, ll. 30–35. Accordingly, it is within the skill of the ordinary artisan to select from known tracers those that can be detected in small quantities for their economic benefits.

Patent Owner contends that a person of ordinary skill in the art would not have found it obvious to combine Chen with the teachings of Hinkel and Deans because Chen teaches a substantially different application from hydraulic fracturing operations and because the tracer study in Chen is substantially different and for a different purpose than the tracer study of the '662 Patent. App. Br. 24–25; Second Wooley Decl. ¶ 17(d).

Patent Owner's arguments are not persuasive for the same reasons discussed above with respect to the combination of Hinkel and Deans. Chen is relied upon for the purpose of showing that certain very low tracer concentrations can be detected after injected into an oil well admixed with a fluid. While we understand that the conditions and studies are different in

Hinkel and Chen, merely pointing out the differences is insufficient in light of the Examiner's reasoning. *See* Second Wooley Decl. ¶ 17(d). Patent Owner has provided no persuasive reasoning or evidence that the skilled artisan would not have expected the tracer of Chen to function successfully in similarly low concentrations in the hydraulic fracturing operation described in Hinkel.

Considering the evidence as a whole, we affirm the Examiner's rejection of claims 5–7 under 35 U.S.C. § 103(a) as unpatentable over Hinkel, Deans, and Chen.

C. Hinkel, Deans, and Hall (Ground XIV, RAN 29–30)

Claim 13

The Examiner relies on Hall as evidence that the use of encapsulated tracers, as recited in claim 13, were known in the art. Hall shows that it was known in the art to inject tracers in the form of pellets of calcium carbide enclosed in a water-proof container, which is smashed at the drill bit and reacted with water to form a detectable gas. Hall, col 1, ll. 4–15. As with any tracer, the "lag time" (i.e., surface injection to return production time) of an injectable material can be calculated between the time injected and the detection of the gas at the surface upon return. According to the Examiner, "it would have been obvious to one of ordinary skill in the art to use tracers in the form of encapsulated solid or liquid in the process of Hinkel and Deans in order to determine the fluid flow characteristics of the drilling mud (e.g. lag time) in the well, as taught by Hall." *See* RAN 30.

Patent Owner contends that a person of ordinary skill in the art would not have found it obvious to combine Hall with the teachings of Hinkel and Deans because Hall is "not analogous art to either Hinkel, Deans, or the claimed method." App. Br. 31.

Patent Owner's arguments are not persuasive for the same reasons discussed above with respect to the combination of Hinkel and Deans. Hall is relied upon for the purpose of showing that encapsulated tracer concentrations can be detected after injected into an oil well admixed with a fluid. While we understand that the conditions and studies are different in Hinkel, Deans and Hall, merely pointing out the differences is insufficient in light of the Examiner's reasoning. Patent Owner has provided no persuasive reasoning or evidence as to why Hall is not analogous art or that the skilled artisan would not have expected the encapsulated tracer of Hall to function successfully in the hydraulic fracturing operation described in Hinkel.

Considering the evidence as a whole, we affirm the Examiner's rejection of claim 13 under 35 U.S.C. § 103(a) as unpatentable over Hinkel, Deans, and Hall.

V. REMAINING REJECTIONS

Because our decision is dispositive regarding the unpatentability of all the claims, we need not reach the merits of the cumulative obviousness rejections based on other references. *See In re Gleave*, 560 F.3d 1331, 1338 (Fed. Cir. 2009) (holding that obviousness rejections need not be reached upon affirming a rejection of all claims as anticipated); *cf. Beloit Corp. v. Valmet Oy*, 742 F.2d 1421, 1423 (Fed. Cir. 1984) (having decided a single

dispositive issue, the ITC was not required to review other matters decided by the presiding officer).

V. CONCLUSION

On the record before us and for the reasons presented above, we affirm the following rejections.

I. The Rejection of claims 1, 5–6, 9, 14, 17 and 19 under 35 U.S.C. § 103(a) as obvious in view of Hinkel in view of Deans;

II. The Rejection of claims 2–4, 10, and 15–21 under 35 U.S.C. § 103(a) as obvious over Hinkel and Deans and further in view of Dugstad;

III. The Rejection of claims 5–7 under 35 U.S.C. § 103(a) as obvious over Hinkel and Deans in view of Chen; and

IV. The Rejection of claim 13 under 35 U.S.C. § 103(a) as obvious over Hinkel, Deans and Hall.

Since we affirm rejections of each claim on appeal, we decline to address the merits of additional grounds of rejection maintained by the Examiner and appealed by the Patent Owner.

In the event neither party files a request for rehearing within the time provided in 37 C.F.R. § 41.79, and this decision becomes final and appealable under 37 C.F.R. § 41.81, a party seeking judicial review must timely serve notice on the Director of the United States Patent and Trademark Office. *See* 37 C.F.R. §§ 90.1 and 1.983.

AFFIRMED

ack

FOR PATENT OWNER:

MOSSMAN, KUMAR & TYLER PC
P.O. BOX 421239
HOUSTON, TX 77242

FOR THIRD-PARTY REQUESTER:

BROWN PATENT LAW, PLLC
2700 N. HEMLOCK CT.
SUITE 111E
BROKEN ARROW, OK 74012

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
95/002,141	09/06/2012	6,659,175 B2	COR-1026-US-RE	5065

87627 7590 02/07/2014
Mossman, Kumar & Tyler PC
P.O. Box 421239
Houston, TX 77242

EXAMINER	
XU, LING X	

ART UNIT	PAPER NUMBER
3991	

MAIL DATE	DELIVERY MODE
02/07/2014	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

PTOL-90A (Rev. 04/07)

Transmittal of Communication to Third Party Requester *Inter Partes* Reexamination	Control No. 95/002,141	Patent Under Reexamination 6,659,175	
	Examiner Ling Xu	Art Unit 3991	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address. --

(THIRD PARTY REQUESTER'S CORRESPONDENCE ADDRESS)

BROWN PATENT LAW, P.L.L.C.
2700 N. HEMLOCK CT. SUITE 111E
BROKEN ARROW, OK 74012

Enclosed is a copy of the latest communication from the United States Patent and Trademark Office in the above-identified reexamination prceeding. 37 CFR 1.903.

Prior to the filing of a Notice of Appeal, each time the patent owner responds to this communication, the third party requester of the *inter partes* reexamination may once file written comments within a period of 30 days from the date of service of the patent owner's response. This 30-day time period is statutory (35 U.S.C. 314(b)(2)), and, as such, it cannot be extended. See also 37 CFR 1.947.

If an *ex parte* reexamination has been merged with the *inter partes* reexamination, no responsive submission by any *ex parte* third party requester is permitted.

All correspondence relating to this inter partes reexamination proceeding should be directed to the **Central Reexamination Unit** at the mail, FAX, or hand-carry addresses given at the end of the communication enclosed with this transmittal.

Right of Appeal Notice (37 CFR 1.953)	Control No. 95/002,141	Patent Under Reexamination 6,659,175
	Examiner Ling Xu	Art Unit 3991

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address. --

Responsive to the communication(s) filed by:
Patent Owner on 16 September, 2013
Third Party(ies) on 07 October, 2013

Patent owner and/or third party requester(s) may file a notice of appeal with respect to any adverse decision with payment of the fee set forth in 37 CFR 41.20(b)(1) within **one-month or thirty-days (whichever is longer)**. See MPEP 2671. In addition, a party may file a notice of **cross** appeal and pay the 37 CFR 41.20(b)(1) fee **within fourteen days of service** of an opposing party's timely filed notice of appeal. See MPEP 2672.

All correspondence relating to this inter partes reexamination proceeding should be directed to the **Central Reexamination Unit** at the mail, FAX, or hand-carry addresses given at the end of this Office action.

If no party timely files a notice of appeal, prosecution on the merits of this reexamination proceeding will be concluded, and the Director of the USPTO will proceed to issue and publish a certificate under 37 CFR 1.997 in accordance with this Office action.

The proposed amendment filed _____ ☐ will be entered ☐ will not be entered*

*Reasons for non-entry are given in the body of this notice.

1a. ☒ Claims 1-7,9 and 11 are subject to reexamination.
1b. ☒ Claims 10 are not subject to reexamination.
2. ☒ Claims 8 have been cancelled.
3. ☐ Claims _____ are confirmed. [Unamended patent claims].
4. ☐ Claims _____ are patentable. [Amended or new claims].
5. ☒ Claims 1-7, 9 and 11 are rejected.
6. ☐ Claims _____ are objected to.
7. ☐ The drawings filed on _____ ☐ are acceptable. ☐ are not acceptable.
8. ☐ The drawing correction request filed on _____ is ☐ approved. ☐ disapproved.
9. ☐ Acknowledgment is made of the claim for priority under 35 U.S.C. 119 (a)-(d) or (f). The certified copy has:
☐ been received. ☐ not been received. ☐ been filed in Application/Control No. _____.
10. ☐ Other _____

Attachments
1. ☐ Notice of References Cited by Examiner, PTO-892
2. ☐ Information Disclosure Citation, PTO/SB/08
3. ☐ _____

DETAILED ACTION

Status of Proceedings

September 6, 2012:	A request for *inter partes* reexamination of claims 1-9 and 11 of United States Patent Number 6,659,175 (hereinafter "the '175 patent") was filed by Third Patent Requester.
November 19, 2012:	An Order granting the request for *inter partes* reexamination of claims 1-9 and 11 of the '175 patent was mailed. A non-final Office action on the merits was also mailed on the same date.
January 22, 2013:	Patent Owner filed a response to the non-final Office action dated November 19, 2012 including an amendment canceling claim 8.
February 20, 2013:	Requester filed comments to Patent Owner's response filed January 22, 2013.
August 16, 2013:	An Action Closing Prosecution (ACP) was mailed.
September 16, 2013:	Patent Owner filed a response to the ACP mailed August 16, 2013.
October 7, 2013:	Requester filed comments to Patent Owner's response filed September 16, 2013.

References Cited

- Deans et al., U.S. Patent No. 4,090,398, hereinafter "Deans";
- Hall, European Patent Application Publication No. 0 282 032, hereinafter "Hall";
- SPE 56427, Dugstad, et al., *Application of Tracers to Monitor Fluid Flow in the Snorre Field: A Field Study*, Society of Petroleum Engineers Inc., 1999, hereinafter "Dugstad";
- Hinkel et al., U.S. Patent No. 6,192,985, hereinafter "Hinkel";
- Teasdale et al., U.S. Patent No. 4,223,725, hereinafter "Teasdale";
- Greenkorn, *Experimental Study of Waterflood Tracers*, Journal of Petroleum Technology, January 1962, pages 87-92, hereinafter "Greenkorn";
- Bowman, *Evaluation of Some New Tracers for Soil Water Studies*, Soil Science Soc. Am. J., Vol. 48, 1984, pages 987-993, hereinafter "Bowman";
- Hoots et al., U.S. Patent No. 4,783,314, hereinafter "Hoots";
- Chen et al., U.S. Patent No. 4,303,411, hereinafter "Chen".

Scope of claims

In reexamination, patent claims are construed broadly. *In re Yamamoto*, 740 F.2d 1569, 1571, 222 USPQ 934, 936 (Fed. Cir.1984) (claims given "their broadest reasonable interpretation consistent with the specification"). Claims 1-7, 9 and 11 of the '175 patent are directed to a method for determining the extent of recovery of materials injected into an oil well. Independent claims 1 and 11 are representative:

> 1. (Amended) A method for determining the extent of recovery of materials injected into a oil well comprising the steps of:

a) preparing a material to be injected into an oil well; wherein the material injected into the oil well is a material useful for hydraulically fracturing the oil well; b) admixing therewith a chemical tracer compound at a predetermined concentration; c) injecting the admixture into an oil well; d) recovering from the oil well a production fluid; e) analyzing the production fluid for the concentration of the chemical tracer present in the production fluid; and f) calculating the amount of admixture recovered from the oil well using the concentration of the chemical tracer present in the production fluid as a basis for the calculation.

11. (Amended) A method for determining the extent of recovery of materials injected into a oil well comprising the steps of: a) preparing a material to be injected into an oil well; wherein the material injected into the oil well is a material useful for hydraulically fracturing the oil well; b) admixing therewith a chemical tracer compound at a predetermined concentration; c) injecting the admixture into an oil well; d) recovering from the oil well a production fluid; e) analyzing the production fluid for the concentration of the chemical tracer present in the production fluid; and f) calculating the amount of admixture recovered from the oil well using the concentration of the chemical tracer present in the production fluid as a basis for the calculation, wherein the tracer is a fluorinated benzoic acid.

Claim Interpretation

Claims 1 and 11 recite a method for determining the extent of recovery of materials injected into an oil well. The claims do not limit the claimed method to be a hydraulically fracturing method. Patent Owner amended claims 1 and 11 by incorporating the claim limitation of original claim 8 into claims 1 and 11. The added limitation recites that "the material injected into the oil well is a material useful for hydraulically fracturing the oil well." However, the claims do not limit the injected material to be used only for hydraulically fracturing process. Accordingly, claims 1 and

11 as amended do not require that the claimed method is a hydraulically fracturing process.

Claim Rejections - 35 USC § 103

The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Requester's Proposed Rejections

I. Claims 1 and 5-6 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Hinkel in view of Deans.

The rejection of claims 1 and 5-6 was proposed by Requester on pages 4-8 and 34-36 of the comments filed on 2/20/2013. The proposed rejection is **adopted** for the following reasons.

Hinkel discloses a hydraulic fracturing method used to stimulate the production of fluids resident in the subsurface, e.g., oil, natural gas, and brines. Hinkel describes that the fracturing method involves breaking or fracturing a portion of the surrounding strata by injecting a specialized fluid into the wellbore directed at the face of the geologic formation (col. 1, lines 45-55). Hinkel also discloses a fracture clean-up process which involves recovering the injected fluid from the fracture (col. 3, lines 9-19 and Examples). Hinkel further discloses that tracers can be added to the various fracturing fluid stages

in actual field applications so that a tracer study can be performed to verify the effectiveness of the fracture clean-up process (see Example 4).

Hinkel does not specify that the amount of fracturing fluid recovered can be determined/calculated based upon the concentration of the tracer in the produced/recovered fluid.

Deans teaches the use of tracer concentration profiles in the produced fluid for material balance purposes to determine/calculate the amount of injected fluid recovered. Deans describes that (col. 3, lines 10-20):

> "[t]he injected fluid preferably contains a tracer to aid in analyzing the flow behavior of the injected fluid within the formation. As the injected fluid flows radially away from the wellbore it dissolves immobile fluid and reduces the immobile fluid saturation. Preferably the flow is reversed and the injected fluid is produced through the injection well in an amount sufficient to determine the volume of injected fluid substantially unsaturated with immobile fluid."

Deans also discloses that the tracer is used only for material balance purposes. The concentration of the trace chemical in the injected fluid can be established by one of ordinary skill in the art using general engineering principles (col. 7, lines 16-20 and 30-32).

Deans further discloses that (col. 6, lines 16-18):

> "[t]he principal purpose for using a tracer is to aid in determining the fluid flow characteristics such as fluid drift and dispersion of the injected fluid. Any suitable tracer can be added to the injected fluid and the return profiles considered in calculating the residual fluid saturation. <u>The chemical tracer is preferably detected and its concentration measured</u> <u>when the produced fluid is analyzed for the dissolved immobile fluid concentration.</u> <u>The tracer concentration profile may be used for determining when the total volume of fluid injected into the formation has been produced.</u> Thus, knowledge of when the volume of injected fluid has been produced can be determined either by knowing the total injected fluid volume or by measuring the tracer concentration profile in the

produced fluid and determining the injected fluid volume using general engineering principles." (Emphasis added).

Accordingly, Deans discloses that the concentration of the tracer in the produced fluid can be measured and used for material balance purpose to determine the fluid flow characteristics including using the tracer concentration profile as a basis to determine the amount of the injected fluid produced (recovered).

Deans also discloses that the injected fluid can be an aqueous fluid such as brine (col. 4, lines 11-15 and claims 2-3). Aqueous fluids are well-known materials useful for hydraulically fracturing an oil well.

Accordingly, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the tracer concentration profiles in the produced/recovered fluid to calculate the amount of injected fluid recovered, as suggested by Deans, in order to determine the effectiveness of the fracture clean-up process disclosed in Hinkel.

With respect to claims 5-6, Deans discloses that the concentration of the tracer in the injected fluid is ranged from about one-half to two percent by volume (5000 - 20,000ppm) (col. 7, lines 33-35), which is within the ranges as recited in claims 5-6.

II. Claims 2-4, 9 and 11 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Hinkel and Deans and further in view of Dugstad.

The rejection of claims 2-4, 9 and 11 was proposed by Requester on pages 4-8 and 34-36 of the comments filed on 2/20/2013. The proposed rejection **is adopted** for the following reasons.

The combination of Hinkel and Deans is relied upon for the reasons stated in I above.

Deans also discloses that the trace chemicals can be selected from a wide category of known and available substances, preferably, the trace chemicals should be soluble in the injected fluid and should have little or no tendency to adsorb on or react with the matrix of the porous medium (col. 7, lines 10-21).

With respect to claims 2-4 and 11, the combination of Hinkel and Deans does not disclose the use of the specific tracers as claimed. However, the tracers as recited in these claims are well known in the art. For example, Dugstad teaches the use of fluorinated benzoic acids (e.g. 4-fluorobenzoic acid) as water tracers in a tracer program to improve the understanding of the flow dynamics and WAG (water-alternating-gas) injection efficiency in the reservoir (page 1, 1st column).

With respect to claim 9, the combination of Hinkel and Deans does not disclose the use of the specific formula as claimed for determining the amount of injected admixture recovered.

Dugstad teaches the use of the following formula to determine the tracer recovery ratio based on the tracer concentration profile (page 2):

$$R_c = \frac{\sum_{i=1}^{n} C_i V_i}{M}$$

wherein *Ci* is the concentration of tracer in sample i, *Vi* is the volume of water produced between samples i and i+1, *M* is the amount of tracer injected, and n is the number of samples collected.

For each sample period or when only a single sample is taken (n=1), the above formula can be simplified as (see pages 15-16 of the request):

$$\mathrm{Rc} = \frac{\mathrm{CV}}{\mathrm{M}} \text{ or } \mathrm{Rc} = \frac{\text{Tracer Rcovered}}{\text{Tracer Injected}}$$

It is noted that the specification of the ‘175 patent indicates that the extent of recovery of materials injected including a tracer is determined by using a mass balance approach (see the ‘175 patent, col. 5, lines 28-34). The amount of tracer recovered can be determined using the following formula, which is also recited in claim 9.

$$\textit{Admixture Recovered} = \left(\frac{\textit{Tracer Recovered}}{\textit{Tracer Injected}}\right) * (\textit{Admixture Injected})$$

The above formula can be rearranged as follow:

$$\frac{\textit{Admixture Recovered}}{\textit{Admixture Injected}} = \frac{\textit{Tracer Recovered}}{\textit{Tracer Injected}}$$

In other words, the ratio or percentage amount of the total Admixture Recovered is equal to the ratio or percentage amount of the Tracer Recovered (see pages 4-6 of the request).

As stated above, Dugstad teaches the use of the following formula to determine the tracer recovery ratio based on the tracer concentration profile:

$$\mathrm{Rc} = \frac{\text{Tracer Rcovered}}{\text{Tracer Injected}}$$

Accordingly, Dugstad teaches the use of the same mass balance approach as described in the '175 patent and in claim 9 to calculate the ratio of the amount of injected fluid recovered based on the tracer concentration profile.

Therefore, it would have been obvious to one of ordinary skill in the art, searching for a suitable trace chemical to aid in determining the fluid flow characteristics in Hinkel and Deans, to select the fluorinated benzoic acid as the tracer since fluorinated benzoic acids are known to be used as a water tracer and have a higher recovery rate than other water tracers (Dugstad, page 2). In order to determine the recovery rate, one skilled in the art would have used the formula provided by Dugstad to calculate/determine the ratio or the amount of injected fluid recovered based on the tracer concentration profile.

III. Claims 5-7 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Hinkel and Deans and further in view of Chen.

The rejection of claims 5-7 was proposed by Requester on pages 4-8 and 34-36 of the comments filed on 2/20/2013. The proposed rejection **is adopted** for the following reasons.

The combination of Hinkel and Deans is relied upon for the reasons stated in I above.

Deans also discloses that the concentration of the trace chemical in the injected fluid can be established by one of ordinary skill in the art using general engineering

principles. As a matter of economics, the concentration of the tracer in the injected fluid can range from about one-half to two percent by volume (5000 - 20,000ppm) (col. 7, lines 33-35).

The combination of Hinkel and Deans does not specify that the concentration range of tracer is from about 100 parts per trillion to about 100 parts per million.

Chen teaches a method for determining flow patterns within a subterranean formation penetrated by an injection system and production system. The method comprises injecting into the formation a saline solution containing a small amount of one or more water-soluble tracer compounds, recovering the saline solution in the production system, determining the depth of recovery, and identifying the tracer compounds by FNMR spectroscopy (col. 1, lines 39-50).

Chen also teaches that the tracer compounds are water-soluble alkali metal salts of inorganic or organic compounds having fluorine in the anion (col. 1, lines 39-50). The amount of the tracer used in the injected solution is small and, preferably, is between about 300 to about 2000ppm (col. 2, lines 39-40). Examples of Chen show that the amount of tracer in the injected solution can be as low as 3 ppm, which is within the range as claimed.

Accordingly, it would have been obvious to one of ordinary skill in the art to use sufficiently small amount of the tracer compounds, as suggested by Chen, in the injected fluids disclosed in Hinkel and Deans in order to lower the operation cost and also reduce the negative effects that the tracers cause to the environment.

IV. Claims 5-7 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Hinkel and Deans and further in view of Hoots.

The rejection of claims 5-7 was proposed by Requester on pages 4-8 and 34-36 of the comments filed on 2/20/2013. The proposed rejection **is adopted** for the following reasons.

The combination of Hinkel and Deans is relied upon for the reasons stated in I above.

Deans also discloses that the concentration of the trace chemical in the injected fluid can be established by one of ordinary skill in the art using general engineering principles. As a matter of economics, the concentration of the tracer in the injected fluid can range from about one-half to two percent by volume (5000 - 20,000ppm) (col. 7, lines 33-35).

The combination of Hinkel and Deans does not specify that the concentration range of tracer is from about 100 parts per trillion to about 100 parts per million.

Hoots teaches a method of using fluorescent tracers in a liquid system to which a treating chemical is added. The method can be utilized in a broad range of aqueous, mixed aqueous/non-aqueous, or non-aqueous liquid systems (e.g. down-hole oil field applications) (col. 3, lines 9-13). The fluorescent tracers are used to quantify and control feed rate(s) of treating chemicals into the liquid system. In addition, the fluorescent tracers can also be used to quantify important characteristics of the liquid

system such as total volume and amount of a liquid entering and leaving the system (col. 1, lines 6-16).

Hoots also teaches (col. 12, lines 61-64) that "[b]y properly choosing the fluorescing reagent, quantitative and in-situ measurement of tracer levels from parts per trillion (ppt) to parts per million (ppm) can be routinely accomplished on an instant or continuous basis with inexpensive portable equipment."

Accordingly, it would have been obvious to one of ordinary skill in the art to use sufficiently small amount of the tracer chemicals, as suggested by Hoots, in the injected fluids disclosed in Hinkel and Deans in order to lower the operation cost and also reduce the negative effects that the tracers cause to the environment.

V. Claims 5-6 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Hinkel and Deans and further in view of Teasdale.

The rejection of claims 5-6 was proposed by Requester on pages 4-8 and 34-36 of the comments filed on 2/20/2013. The proposed rejection **is adopted** for the following reasons.

The combination of Hinkel and Deans is relied upon for the reasons stated in I above.

Deans also discloses that the concentration of the trace chemical in the injected fluid can be established by one of ordinary skill in the art using general engineering principles. As a matter of economics, the concentration of the tracer in the injected fluid

can range from about one-half to two percent by volume (5000 - 20,000ppm) (col. 7, lines 33-35).

Teasdale teaches (col. 1, lines 48-59) that:

> "a method for determining the magnitude of the fluid drift rate within a reservoir. The method comprises the steps of first injecting a known volume of a tracer-containing fluid into the reservoir, then waiting for a period of time sufficient to allow movement of the injected tracer containing fluid under the influence of the reservoir fluid drift rate, then producing fluids from said well while systematically analyzing produced fluid samples to determine the produced fluid tracer concentration, and finally calculating therefrom the magnitude of the fluid drift rate in the reservoir."

Teasdale also teaches the use of well-known tracers such as sodium bromide, potassium iodide and lithium chloride (col. 1, lines 66-col. 2, lines 10) at a concentration of 1,000 ppm (col. 1, lines 66-col. 2, line 10), which is within the range as recited in claims 5-6.

Accordingly, it would have been obvious to one of ordinary skill in the art to use sufficiently smaller amount of the tracer chemicals, as suggested by Teasdale, in the injected fluids disclosed in Hinkel and Deans in order to lower the cost and also reduce the negative effects that the tracers cause to the environment.

VI. Claims 5-7 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Hinkel and Deans and further in view of Greenkorn.

The rejection of claims 5-7 was proposed by Requester on pages 4-8 and 34-36 of the comments filed on 2/20/2013. The proposed rejection **is adopted** for the following reasons.

The combination of Hinkel and Deans is relied upon for the reasons stated in I above.

Deans also discloses that the concentration of the trace chemical in the injected fluid can be established by one of ordinary skill in the art using general engineering principles. As a matter of economics, the concentration of the tracer in the injected fluid can range from about one-half to two percent by volume (5000 - 20,000ppm) (col. 7, lines 33-35).

The combination of Hinkel and Deans does not specify that the concentration range of tracer is from about 100 parts per trillion to about 100 parts per million.

Greenkorn teaches the use of tracers in injected fluids to determine the flow paths of waterflood or subsurface liquids. Examples of the water tracers include tritiated water, bromine, chloride, and iodide (page 89). The experimental study performed by Greenkorn indicates that these tracers give similar breakthrough-elution curves and material balances within practical accuracy, and the analysis of these tracers are relatively simple (page 89). Greenkorn also teaches that the amount of the tracer in the injected fluids can be as low as 71.4 ppm and 79 ppm, which are within the ranges as recited in claims 5-7.

Accordingly, it would have been obvious to one of ordinary skill in the art to use sufficiently small amount of the tracer compounds, as suggested by Greenkorn, in the injected fluids disclosed in Hinkel and Deans in order to lower the operation cost and also reduce the negative effects that the tracers cause to the environment.

VII. Claims 2-4 and 11 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Hinkel and Deans in view of Teasdale and further in view of Bowman.

The rejection of claims 2-4 and 11 was proposed by Requester on pages 4-8 and 34-36 of the comments filed on 2/20/2013. The proposed rejection **is adopted** for the following reasons.

The combination of Hinkel and Deans is relied upon for the reasons stated in I above.

Deans also discloses that the trace chemicals can be selected from a wide category of known and available substances, preferably, the trace chemicals should be soluble in the injected fluid and should have little or no tendency to adsorb on or react with the matrix of the porous medium (col. 7, lines 10-21).

The combination of Hinkel and Deans does not disclose the use of the specific tracers as recited in claims 2-4 and 11.

Teasdale teaches (col. 1, lines 48-59) that:

> "a method for determining the magnitude of the fluid drift rate within a reservoir. The method comprises the steps of first injecting a known volume of a tracer-containing fluid into the reservoir, then waiting for a period of time sufficient to allow movement of the injected tracer containing fluid under the influence of the reservoir fluid drift rate, then producing fluids from said well while systematically analyzing produced fluid samples to determine the produced fluid tracer concentration, and finally calculating therefrom the magnitude of the fluid drift rate in the reservoir."

Teasdale also teaches the use of well-known tracers such as sodium bromide, potassium iodide, lithium chloride (col. 1, lines 66-col. 2, lines 10).

Bowman discloses the use of water tracers including deuterated and tritiated water, bromine, chloride, and iodide in soil water. Of these common water tracers, Bowman describes that bromide is the most generally suitable tracer for soil water (page 987). In addition, a study performed by Bowman also indicates that the following tracers exhibit characteristics most similar to bromide: (i) o-(trifluoromethyl)benzoic acid (o-TFMBA), (ii) penta fluoro benzoic acid (PFBA), and (iii) 2,6- difluorobenzoic acid (2,6 - DFBA). These tracers are particularly useful in field studies when multiple tracers or totally exotic tracers are desired (page 992).

Accordingly, it would have been obvious to one of ordinary skill in the art, searching for a suitable trace chemical for use in the injected fluids disclosed in Hinkel and Deans, to select the fluorinated benzoic acids as the tracer since these fluorinated benzoic acids exhibit highly desirable performance and characteristics including resistance to chemical and microbial degradation (see Bowman, page 988, 1st column) in natural environments and environments where totally exotic tracers are desired.

VIII. Claims 2-4 and 11 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Hinkel and Deans in view of Greenkorn and further in view of Bowman.

The rejection of claims 2-4 and 11 was proposed by Requester on pages 4-8 and 34-36 of the comments filed on 2/20/2013. The proposed rejection **is adopted** for the following reasons.

The combination of Hinkel and Deans is relied upon for the reasons stated in I above.

Deans also discloses that the trace chemicals can be selected from a wide category of known and available substances, preferably, the trace chemicals should be soluble in the injected fluid and should have little or no tendency to adsorb on or react with the matrix of the porous medium (col. 7, lines 10-21).

The combination of Hinkel and Deans does not disclose the use of the specific tracers as recited in claims 2-4 and 11. However, the tracers as recited in these claims are well known in the art.

For example, Greenkorn teaches the use of tracers in injected fluids to determine the flow paths of waterflood or subsurface liquids. Examples of the water tracers include tritiated water, bromine, chloride, and iodide (page 89). The experimental study performed by Greenkorn indicates that these tracers give similar breakthrough-elution curves and material balances within practical accuracy, and the analysis of these tracers are relatively simple (page 89).

Bowman discloses the use of water tracers including deuterated and tritiated water, bromine, chloride, and iodide in soil water. Of these common water tracers, Bowman describes that bromide is the most generally suitable tracer for soil water (page 987). In addition, a study performed by Bowman also indicates that the following tracers exhibit characteristics most similar to bromide: (i) o-(trifluoromethyl)benzoic acid (o-TFMBA), (ii) penta fluoro benzoic acid (PFBA), and (iii) 2,6- difluorobenzoic acid (2,6

- DFBA). These tracers are particularly useful in field studies when multiple tracers or totally exotic tracers are desired (page 992).

Accordingly, it would have been obvious to one of ordinary skill in the art, searching for a suitable trace chemical for use in the injected fluids disclosed in Hinkel and Deans, to select the fluorinated benzoic acids as the tracer since these fluorinated benzoic acids exhibit highly desirable performance and characteristics including resistance to chemical and microbial degradation (see Bowman, page 988, 1st column) in natural environments and environments where totally exotic tracers are desired.

IX. Claims 1 and 5-6 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Hinkel in view of Hall.

The rejection of claims 1 and 5-6 was proposed by Requester on pages 4-8 and 34-36 of the comments filed on 2/20/2013. The proposed rejection is **adopted** for the following reasons.

Hinkel is relied upon for the reasons stated in I above.

Hinkel does not specify that the amount of fracturing fluid recovered can be determined/calculated based upon the concentration of the tracer in the produced/recovered fluid.

Hall teaches a method for monitoring drilling mud circulation in a well wherein a tracer is added to the aqueous drilling mud. Specifically, Hall describes (col. 2, lines 29-41):

> "a method for the monitoring of drilling mud circulation in a wellbore, by injecting in a discrete way a known amount or concentration of at least

> one tracer ion in the supply mud and by analysing on site the return mud for the tracer, said tracer ion being substantially non-interactive with the other mud components and with the strata drilled, the concentration of said tracer ion being measured, as a function of time, in the return mud and its residence time density function f(t) being determined from said measured concentration in order to assess the hydrodynamic dispersion of the circulating mud."

Hall also discloses a preferred operation involves injecting a quantity of tracer into the mud inlet at the surface; detecting quantitatively the time variation of the tracer concentration as it returns to the surface; processing the tracer return concentration data to obtain a residence time distribution for the circulation; using the time distribution to obtain information on the circulation.

Hall further discloses that, if the tracer is inert, any loss of tracer can be interpreted as a loss of fluid in the wellbore (col. 7, lines 6-8). The tracer concentration curve generated from the operation can be used to measure fluid loss during circulation. Specifically, with respect to Figure 8, Hall states that (Col. 3, lines 26-35):

> "since the area under the tracer outflow concentration curve eg., area under $C_{out}(t)$ in Fig. 8, is equal to the total amount of tracer material washed out from the well during circulation, a comparison of this quantity with the total amount injected into the well gives, by difference, a measure of fluid loss during circulation (provided the tracer is non-interactive with the mud components and the formation drilled)."

Based on the amount of the fluid loss during circulation, the amount of fluid recovered (the amount of fluid not lost) can also be determined/calculated by comparing the amount of the fluid injected into the well and the amount of the fluid loss during circulation. Accordingly, Hall teaches that the amount of the injected fluid recovered from the well can be determined/calculated based on the concentration of the tracer present in the outflow fluid.

Hall also discloses a process of drilling of wellbore into an earth formation using drilling mud/fluid (col. 1, lines 1-30). It is well known in the art that the drilling process disclosed in Hall is most often used for drilling oil and natural gas wells.

Accordingly, it would have been obvious to one of ordinary skill in the art to use the tracer concentration in the produced/recovered fluid to calculate the amount of injected fluid recovered, as suggested by Hall, in order to determine the effectiveness of the fracture clean-up process disclosed in Hinkel.

With respect to claims 5-6, Hall discloses that the concentration of the tracer in the injected fluid is sufficiently small, typically 1% by weight (10,000 ppm) (col. 5, lines 12-15), which is within the ranges as recited in claims 5-6.

X. Claims 2-4, 9 and 11 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Hinkel and Hall and further in view of Dugstad.

The rejection of claims 2-4, 9 and 11 was proposed by Requester on pages 4-8 and 34-36 of the comments filed on 2/20/2013. The proposed rejection **is adopted** for the same reasons as recited above.

The combination of Hinkel and Hall is relied upon for the reasons stated in IX above.

Hall also discloses that the choice of tracers is governed by the surface analytical system available, provided that the tracer species do not adsorb on the borehole wall

and they are inert to the fluid components (col. 5, line 55- col. 6, line 13). Examples of traces include lithium bromide and zinc bromide.

With respect to claims 2-4 and 11, the combination of Hinkel and Hall does not disclose the use of the specific tracers as claimed. However, the tracers as recited in these claims are well known in the art. For example, Dugstad teaches the use of fluorinated benzoic acids (e.g. 4-fluorobenzoic acid) and tritiated water as water tracers in a tracer program to improve the understanding of the flow dynamics and WAG (water-alternating-gas) injection efficiency in the reservoir (page 1, 1st column).
With respect to claim 9, the combination of Hinkel and Hall does not disclose the use of the specific formula as claimed for determining the amount of injected admixture recovered.

As stated above in II, Dugstad teaches the use of the same mass balance approach as described in the '175 patent and in claim 9 to calculate the ratio of the amount of injected fluid recovered based on the tracer concentration profile.

Accordingly, it would have been obvious to one of ordinary skill in the art, searching for a suitable trace chemical to aid in determining the fluid flow characteristics in Hinkel and Hall, to select the fluorinated benzoic acid as the tracer since fluorinated benzoic acids are known to be used as a water tracer and have a higher recovery rate than other water tracers (Dugstad, page 2). In order to determine the recovery rate, one skilled in the art would have used the formula provided by Dugstad to calculate/ determine the ratio or the amount of injected fluid recovered based on the tracer concentration in the recovered fluid.

XI. Claims 5-7 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Hinkel and Hall and further in view of Chen.

The rejection of claims 5-7 was proposed by Requester on pages 4-8 and 34-36 of the comments filed on 2/20/2013. The proposed rejection **is adopted** for the following reasons.

The combination of Hinkel and Hall is relied upon for the reasons stated in IX above.

Hall also discloses that the choice of tracers is governed by the available surface analytical system, provided that the tracer species do not adsorb on the borehole wall and they are inert to the fluid components (col. 5, line 55- col. 6, line 13). Examples of traces for use with an ion-chromatography system include lithium bromide and zinc bromide.

Hall further discloses that the concentration of the tracer in the injected fluid is sufficiently small, typically 1% by weight (10,000 ppm) (col. 5, lines 12-15).
The combination of Hinkel and Hall does not specify that the concentration range of tracer is from 100 parts per trillion to about 100 parts per million.

Chen teaches a method for determining flow patterns within a subterranean formation penetrated by an injection system and production system. The method comprises injecting into the formation a saline solution containing a small amount of one or more water-soluble tracer compounds, recovering the saline solution in the

production system, determining the depth of recovery, and identifying the tracer compounds by FNMR spectroscopy (col. 1, lines 39-50).

Chen also teaches that the tracer compounds are water-soluble alkali metal salts of inorganic or organic compounds having fluorine in the anion (col. 1, lines 39-50). The amount of the tracer used in the injected solution is small and, preferably, is between about 300 to about 2000ppm (col. 2, lines 39-40). Examples of Chen show that the amount of tracer in the injected solution can be as low as 3 ppm, which is within the range as claimed.

Accordingly, it would have been obvious to one of ordinary skill in the art to use sufficiently small amount of the tracer compounds, as suggested by Chen, in the injected fluids disclosed in Hinkel and Hall in order to lower the operation cost and also reduce the negative effects that the tracers cause to the environment.

XII. Claims 5-7 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Hinkel and Hall and further in view of Hoots.

The rejection of claims 5-7 was proposed by Requester on pages 4-8 and 34-36 of the comments filed on 2/20/2013. The proposed rejection **is adopted** for the following reasons.

The combination of Hinkel and Hall is relied upon for the reasons stated in IX above.

Hall also discloses that the choice of tracers is governed by the available surface analytical system, provided that the tracer species do not adsorb on the borehole wall and they are inert to the fluid components (col. 5, line 55- col. 6, and line 13). Examples of traces for use with an ion-chromatography system include lithium bromide and zinc bromide.

Hall further discloses that the concentration of the tracer in the injected fluid is sufficiently small, typically 1% by weight (10,000 ppm) (col. 5, lines 12-15).

The combination of Hinkel and Hall does not specify that the concentration range of tracer is from 100 parts per trillion to about 100 parts per million.

Hoots teaches a method of using fluorescent tracers in a liquid system to which a treating chemical is added. The method can be utilized in a broad range of aqueous, mixed aqueous/non-aqueous, or non-aqueous liquid systems (e.g. down-hole oil field applications) (col. 3, lines 9-13). The fluorescent tracers are used to quantify and control feed rate(s) of treating chemicals into the liquid system. In addition, the fluorescent tracers can also be used to quantify important characteristics of the liquid system such as total volume and amount of a liquid entering and leaving the system (col. 1, lines 6-16).

Hoots also teaches (col. 12, lines 61-64) that "[b]y properly choosing the fluorescing reagent, quantitative and in-situ measurement of tracer levels from parts per trillion (ppt) to parts per million (ppm) can be routinely accomplished on an instant or continuous basis with inexpensive portable equipment."

Accordingly, it would have been obvious to one of ordinary skill in the art to use sufficiently small amount of the tracer chemicals, as suggested by Hoots, in the injected fluids disclosed in Hinkel and Hall in order to lower the operation cost and also reduce the negative effects that the tracers cause to the environment.

XIII. Claims 2-4 and 11 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Hinkel and Hall and further in view of Bowman.

The rejection of claims 2-4 and 11 was proposed by Requester on pages 4-8 and 34-36 of the comments filed on 2/20/2013. The proposed rejection **is adopted** for the following reasons.

The combination of Hinkel and Hall is relied upon for the reasons stated in IX above.

Hall also discloses that the choice of tracers is governed by the available surface analytical system, provided that the tracer species do not adsorb on the borehole wall and they are inert to the fluid components (col. 5, line 55- col. 6, line 13). Examples of traces for use with an ion-chromatography system include lithium bromide and zinc bromide.

The combination of Hinkel and Hall does not disclose the specific tracers as recited in claims 2-4 and 11.

Bowman discloses the use of water tracers including deuterated and tritiated water, bromine, chloride, and iodide in soil water. Of these common water tracers,

Bowman describes that bromide is the most generally suitable tracer for soil water (page 987). In addition, a study performed by Bowman also indicates that the following tracers exhibit characteristics most similar to bromide: (i) o-(trifluoromethyl)benzoic acid (o-TFMBA), (ii) penta fluoro benzoic acid (PFBA), and (iii) 2,6- difluorobenzoic acid (2,6 - DFBA). These tracers are particularly useful in field studies when multiple tracers or totally exotic tracers are desired (page 992).

Accordingly, it would have been obvious to one of ordinary skill in the art, searching for a suitable trace chemical for use in the injected fluids disclosed in Hinkel and Hall, to select the fluorinated benzoic acids as the tracer since fluorinated benzoic acids exhibit highly desirable performance and characteristics including resistance to chemical and microbial degradation (see Bowman, page 988, 1st column) in natural environments and environments where totally exotic tracers are desired.

Response to Patent Owner's Arguments filed on 1/22/2013

In response to the first non-final Office action filed on 11/9/2012, Patent Owner presents the following arguments.

1. <u>Rejection Based on Hinkel in View of Deans</u>

A. Patent Owner argues that tracers are not a primary purpose of the Hinkel patent and the Hinkel patent is directed to the concept of first recovering fracture fluid that was injected. Its only disclosure of a tracer study is to measure whether this happens. The Hinkel patent makes no claims with respect to tracers and the Hinkel

patent makes no other mention of using tracers. Similarly, tracers are not an essential part of the Deans patent (see pages 12-13 of the response filed on 1/22/2013).

As stated in I above, Hinkel clearly discloses the use of tracers to determine the recovery of the injected fluid. Hinkel describes that the tracers can be added to various fracturing fluid stages so that a tracer study can be performed to verify the effectiveness of the fracture clean-up process (see Example 4). As also stated by Requester (pages 9-10 of the comments filed on 2/20/2013),

> "[a]lthough Hinkle et al. certainly desire to know which tracer is the first one to appear at the wellhead, it is readily apparent, based upon the express goal and purposes of the Hinkle et al. process as discussed throughout the Hinkel et al. patent, that Hinkel et al. desire to know a great deal more. For example, Hinkle et al. desire to know:
>
> - How much fracturing fluid has been recovered (Id. at column 3, lines 5-8; column 4, lines a 30-50; and column 4 line 67 - column 5, line 4)
> - How much fracturing fluid has been left in the fracture (Id. at column 2 lines 51-53)
> - Whether all or most of the fracturing fluid has been recovered from the fracture tip (Id. at column 2, lines 61-64; column 3, lines 20-22 and; column 5, lines 2-5)"

Similarly, Deans also teaches the use of the tracer concentration profile as a basis to determine the amount of the injected fluid produced (recovered) (col. 6, lines 16-18). Deans describes that the principal purpose for using a tracer is to aid in determining the fluid flow characteristics such as fluid drift and dispersion of the injected fluid.

Accordingly, both Hinkel and Deans clearly teach the use of the tracers to determine the extent of recovery of the injected materials as claimed. A reference may be relied upon for all that it would have reasonably suggested to one having ordinary

skill the art, including nonpreferred embodiments. *Merck & Co. v. Biocraft Laboratories*, 874 F.2d 804, 10 USPQ2d 1843 (Fed. Cir.), cert. denied, 493 U.S. 975 (1989). *See* also *Celeritas Technologies Ltd. v. Rockwell International Corp.*, 150 F.3d 1354, 1361, 47 USPQ2d 1516, 1522-23 (Fed. Cir.1998). Disclosed examples and preferred embodiments do not constitute a teaching away from a broader disclosure or nonpreferred embodiments. *In re Susi*, 440 F.2d 442, 169 USPQ423 (CCPA 1971). *See* MPEP 2123.

B. Patent Owner also argues that the Deans patent discusses reservoir "flooding" and not hydraulic fracturing. Water flooding is a very different process as compared to hydraulic fracturing. One of ordinary skill in the art would not have combined Deans with Hinkel because these two patents are incompatible in their teachings (see pages 13-15 of the response filed on 1/22/2013).

As stated above in the Claim Interpretation, claims 1 and 11 as amended do not require that the claimed method is a hydraulically fracturing process. It is also noted that the specification of the '175 patent does <u>not</u> describe that the inventive method only applies to a hydraulic fracturing process. In fact, the '175 patent states that the inventive method can be used in a drilling, fracturing or any other operation requiring the injection of materials into an oil well (col. 1 lines 57-64 and col. 3, lines 29-34). The '175 patent also describes that the drilling fluid can be "drilling muds" (col. 3, lines 21-22) and the inventive method can be used in a well "for water flooding in secondary recovery operations in oil and gas production" (col. 2, lines 17-20).

Accordingly, the '175 patent is directed to a method of using a tracer for determining the extent of recovery of materials injected into an oil well during oil and gas exploration and production, which includes drilling, fracturing and water flooding.

It has been held that a prior art reference must either be in the field of applicant's endeavor or, if not, then be reasonably pertinent to the particular problem with which the applicant was concerned, in order to be relied upon as a basis for rejection of the claimed invention. See *In re Oetiker*, 977 F.2d 1443, 24 USPQ2d 1443 (Fed. Cir. 1992).

The prior art references, Hinkel and Deans, teach the method of using tracers to determine the recovery of the injected fluids in oil and gas field operations. Hinkel teaches the use of tracers in a hydraulic fracturing and Deans teaches the use of tracers in a water flooding. Both processes are field operations requiring the injection of materials into an oil well. The '175 patent discusses the need/desire of using tracers in oil and gas field operations to determine the recovery of the injected material. The oil and gas operations include drilling, fracturing and any other operation requiring the injection of materials into an oil well (including the water flooding operation). Accordingly, Hinkel and Deans are in the same field of endeavor as the claimed invention. The teachings of Hinkel and Deans are highly pertinent to the particular problems/needs faced by Patent Owner at the time of the invention of the ‘175 patent. One of ordinary skill in the art, seeking to determine the recovery of the injected material in an oil well, would use the tracer concentration profiles in the produced/recovered fluid

to calculate the amount of injected fluid recovered, as suggested by Deans, to determine the effectiveness of the fracture clean-up process disclosed in Hinkel.

As also argued by Requester (pages 13-14 of the comments filed on 2/20/2013):

> “[t]he teachings of Dean, Hall, and Hinkel are all indeed pertinent to the current considerations relating to the use of tracers in oilfield operations. Dean involves water flooding, Hall involves drilling applications, and Hinkel mention use of tracers in fracturing. All three of these events (waterflooding, drilling, and hydraulic fracturing) involve the introduction of an alien fluid into a formation to enhance well production. In all three processes it is obviously important that what happens to that alien fluid in the formation can impact well productivity. From the cited work, it is taught that tracers can be used to provide needed information as to what is happening or has happened to the alien fluid in hydrocarbon formations. For example, with drilling (Hall), mud loss to a producing formation as indicated by tracers provides information concerning mud loss related to formation damage or even pending well control issues. Tracers placed into an alien fluid used for water flooding provide information about flood fronts, water breakthrough (thus bypassing production), etc. as the tracers appear at the producing well. Tracers in hydraulic fracturing (as taught by Hinkel) provide information about improvement in frac fluid returns and enhancement of the fracture system by improving polymer breaks and flow from the fracture tip.”

Requester also states that (page 14 of the comments filed on 2/20/2013):

> “the Patent Owner itself, in every one of its published annual reports since at least as early as 1998 (i.e. the year that the Hinkel et al. patent application was filed), has described the interrelated nature of hydraulic fracturing and flooding procedures and has noted that the two procedures are often performed in tandem. A copy of the Patent Owner's 10-K Annual Report for 1998 is appended hereto as Exhibit B.”

The Patent Owner’s 10-K Annual Report for 1998 (page 5) confirms that “many oilfields today are hydraulically fractured and flooded to maximize hydrocarbon recovery.”

Other evidence of record also suggests that the type of tracer study described by Deans can be used for monitoring injected fluids in numerous different downhole operations. As stated by Requester, Hoots teaches that,

> “tracer study procedures can be used in all manner of downhole operations ‘to quantify important characteristics of the system such as total volume and amount of liquid entering and leaving the system’ (Hoots et al. column 1, lines 5-17) and, ‘[f]or example, oilfield applications (drilling, secondary and tertiary recovery methods, etc.)’ (Id. at column 11, lines 37-38). Hoots et al. further state that: ‘The invention can be utilized in a broad range of aqueous, mixed aqueous/non-aqueous, or non-aqueous liquid systems (e.g. .... down-hole oilfield applications...) (Id. at column 3, lines 9-13).”

C. Patent Owner also cites the description of Deans at col. 7, lines 36-47 and argues that Deans teaches away from hydraulic fracturing (see pages 14- 16 of the response filed on 1/22/2013).

Although Deans states, at col. 7, lines 36-47, that the injection rate should be sufficiently high so that the injected fluid can move through the formation against fluid drift and the injection rate should not be so high that the formation will fracture, this statement is specifically directed to the water flooding process. Deans also states that “the injection rate is not a significant factor in the analysis of the results because the rate of immobile fluid adsorption by the injected fluid is relatively independent of the injected fluid flow rate. The production rate should not significantly change the formation fluid pressure.” Deans further states that “the injection and production rates of the fluids can be established by those skilled in the art by taking into account such factors as the reservoir conditions and injection and production facilities” (col. 7, lines 36-47).

Accordingly, Deans does not teach away from hydraulic fracturing or any other oil and gas field operations requiring the injection of materials into an oil well. One skilled in the art, when combining the teaching of Deans with Hinkel's process, would have taken into account the reservoir conditions and injection and production facilities used in

Hinkel's process and establish sufficient injection and production rates of the fluids for Hinkel's process.

As also argued by Requester (page 11-12 of the comments filed on 2/20/2013),

> "Deans et al. do not teach or suggest that there is any special relationship between tracer studies and the flow rates used in waterflooding operations so that tracer studies should not be used in conjunction with hydraulic fracturing operations or other operations conducted at different flow rates. Rather, as admitted by the Patent Owner on page 13 of the Response, "tracers are not an essential part of the Deans patent." In fact, consistent with the Patent Owner's own observation, Deans et al. indicate at column 7, lines 15-18 that the presence of small amounts of chemical tracers has no bearing upon the performance, success, or failure of such operations but rather "as previously mentioned, the tracer in this invention is used only for material balance purposes and is not an essential feature of the invention."

2. <u>Rejection Based on Hinkel in View of Hall</u>

A. Patent Owner argues that Hall is unrelated to production of oil and gas from reservoirs, but instead relates to monitoring drilling mud during the drilling process. Hall does not address hydraulic fracturing. Rather, Hall teaches the use of tracers to assess dispersion of the circulating-mud in a well during drilling (see pages 18-19 of the response filed on 1/22/2013).

For the same reasons as stated above in section 1 (A), claims 1 and 11 as amended do not require that the claimed method is a hydraulic fracturing process nor does the '175 patent describe that the inventive method only applies to the hydraulic fracturing process. In fact, the '175 patent describes that the claimed process can be a fracturing process, a drilling process and the like and the drilling fluid can be "drilling muds."

Further, Hinkel clearly discloses the use of tracers to determine the recovery of the injected fluid. Hinkel describes that the tracers can be added to various fracturing fluid stages so that a tracer study can be performed to verify the effectiveness of the fracture clean-up process (see Example 4). Hall teaches a method for monitoring drilling mud circulation in a well wherein a tracer is added to the aqueous drilling mud. Hall describes that the amount of the injected fluid recovered from the well can be determined /calculated based on the concentration of the tracer present in the outflow fluid. Accordingly, both Hinkel and Hall teach the method of using tracers to determine the recovery of the injected fluids in oil and gas field operations (including the hydraulic fracturing or drilling process using drilling muds). Both processes are field operations requiring the injection of materials in oil and gas field operations.

As stated above, the '175 patent discusses the need/desire of using tracers in the oil and gas field operations to determine the recovery of the injected material. The oil and gas operations include drilling, fracturing and any other operation requiring the injection of materials into an oil well. Accordingly, Hinkel and Hall are in the same field of endeavor as the claimed invention. The teachings of Hinkel and Hall are highly relevant to the particular problems/needs faced by Patent Owner at the time of the invention of the ‘175 patent. One of ordinary skill in the art, seeking to determine the recovery of the injected material in an oil well, would use the tracer concentration in the produced/recovered fluid to calculate the amount of injected fluid recovered, as suggested by Hall, in order to determine the effectiveness of the fracture clean-up process disclosed in Hinkel.

B. Patent Owner also argues that the only potential determination that Hall makes is "a measure of fluid loss during circulation (provided the tracer is non-interactive with the mud components and the formation drilled)." This is exactly opposed to the purpose of the '175 Patent which is directed to "calculating the amount of admixture recovered", not to the fluid lost during the operation (see page 19 of the response filed on 1/22/2013).

Hall discloses more than just "a measure of fluid loss during circulation". Hall discloses that the concentration of the tracer ion is measured, as a function of time, in the return mud. The residence time density function f(t) is determined from the measured concentration in order to assess the hydrodynamic dispersion of the circulating mud (col. 2, lines 29-41). Hall describes that the tracer return concentration data is processed to obtain a residence time distribution for the circulation. The time distribution is used to obtain information on the circulation.

In considering the disclosures of prior art references, it is appropriate to take into account not only the specific teachings of the references but also the inferences one skilled in the relevant art would reasonably be expected to draw therefrom. *In re Preda*, 401 F.2d 825, 826-27 (CCPA 1968), also see MPEP 2144.01.

Although Hall discloses that (col. 7, lines 6-8) the tracer concentration curve generated from the operation can be used to measure fluid loss during circulation, the amount of fluid recovered (the amount of fluid not lost) can also be determined / calculated based on the amount of the fluid loss during circulation (see Rejection XIII

above). Accordingly, Hall implicitly discloses that the amount of the fluid recovered from the well can be determined/calculated based on the concentration of the tracer present in the outflow fluid. It would have also been obvious to one of ordinary skill in the art to determine the amount of the fluid recovered (the amount of fluid not lost) from the well based on the concentration of tracer present in the outflow fluid by a simple material balance, i.e. by calculating/determining the difference between the amount of the fluid injected into the well and the amount of fluid loss in the wellbore.

3. <u>Secondary Consideration</u>

A. Patent Owner cites Mr. J. Thomas Hampton's declaration and argues that Mr. Hampton demonstrates, in a claim chart (Ex. H), a correlation (nexus) between the elements of the combination of original patented claims 1 and 8 and the commercial process known as SPECTRAGHEM® as evidenced by the brochure filed with Mr. Hampton's declaration (see pages 20-22 of the response filed on 1/22/2013).

Although the SPECTRAGHEM® brochure states that SPECTRACHEM® is a patented chemical tracer technology, the brochure does not show that the technology is a process directly derived from the claimed invention recited in the '175 patent.

The brochure generally states that the SPECTRACHEM® service involves injecting tracers into different fracturing stages or segments of a single or multi-stage stimulation procedure. However, it does not describe that the process involves admixing a material with the tracers and injecting the admixture into the oil well as claimed.

The brochure also states that flowback samples are analyzed but does not specify that the flowback samples are analyzed for the concentration of the tracer present in the production fluid as claimed.

The brochure further states that the tracers are routinely used to quantify and profile fracturing fluid clean-up and flowback efficiency over time. However, the brochure does not specify that the amount of the admixture of the tracer and the injected material recovered are calculated using the concentration of the tracer present in the production fluid as a basis as claimed.

Further, the brochure does not provide any evidence of commercial success of the SPECTRAGHEM® technology. Accordingly, for the reasons stated above, the evidence provided by Patent Owner is insufficient to establish any secondary consideration based on the brochure of the commercial SPECTRACHEM® technology.

B. Patent Owner also cites the Hampton declaration and argues that the subject patent satisfies a long-felt need (see pages 22-23 of the response filed on 1/22/2013).

While Mr. Hampton states in the Hampton declaration (¶ 6) that “a need existed prior to July 2001 for some diagnostic tool to determine the extent of recovery of hydraulic fracturing fluid,” Mr. Hampton fails to provide sufficient evidence to show that the determination of the extent of recovery of hydraulic fracturing fluid is an art recognized problem that existed in the art for a long period of time without a solution. *See* MPEP 716.04.

The Hampton declaration cites a journal article, SPE 31094 (Ex. B), and argues that SPE 31094 recognizes the need that existed (¶ 7). However, SPE 31094 also teaches a solution to solve the identified problem. SPE 31094 teaches a more quantifiable approach than the conventional method to maximize fracture cleanup and well productivity (see page 239 of SPE 31094). As also stated by Requester (pages 24-25 of the comments filed on 2/20/2013),

> "the article makes clear that any needs mentioned by the authors of article, whether real or imagined, were addressed and resolved in 1996 by the publication of the article itself. Consequently, any need or desire expressed in the article was resolved well prior to the Patent Owner's first commercial job in July 2001."

Accordingly, the evidence provided by Patent Owner fails to establish that the claimed invention satisfies a long-felt need, which was recognized, persistent, and not solved by others. See MPEP 716.04.

C. Patent Owner also cites the Hampton declaration and argues that there have been many articles published in professional journals praising the benefits of the invention (see pages 23-25 of the response filed on 1/22/2013).

The cited articles, SPE 95064 (Ex. C), SEP 77750 (Ex. D), SPE 84486 (Ex. E), SPE 140105 (Ex. F), describe the use of "chemical frac tracing technology." However, there is no evidence indicating that the chemical frac tracing technology is derived from the claimed invention.

In addition, as argued by Requester (pages 26-27 of the comments filed on 2/20/2013),

> "these articles "were all written by the Patent Owner, not by "others." Specifically: three of the five authors listed on the article of Exhibit C are employees of ProTechnics; three of the four authors listed on the article of Exhibit D are employees of ProTechnics; three of the four authors listed on the article of Exhibit E are employees of ProTechnics; and one of the two authors listed on the article of Exhibit F is an employee of ProTechnics."

As noted by Requester, "ProTechnics" is a division of Core Laboratories (Patent Owner).

Patent Owner also provides an email comment from a customer (Ex. G). The email appears to describe field operations using tracer. However, the only "praise" from the customer related to the benefit of using tracer is that "the tracer data has really proven to be a good investment." This is insufficient to establish the nexus between the operation described in the email and the claimed invention.

D. Patent Owner cites Mr. Hampton's declaration (¶ 8) and Dr. Gary Wooley's declaration (¶¶ 22-24) and argues that the invention of the '175 patent has been copied 3 times. The most recent is by Requester, a former employee of the patentee. There is litigation ongoing at this time regarding their infringement. There have been two other litigations. Dr. Gary's declaration states that evidence of infringement proves that Requester copied the invention of claims 1 and 8 (¶ 24) (see page 25 of the response filed on 1/22/2013).

Patent Owner's arguments are not persuasive. More than the mere fact of copying is necessary to make that action significant because copying may be attributable to other factors such as a lack of concern for patent property or contempt for the patentee's ability to enforce the patent. *Cable Electric Products, Inc. v. Genmark,*

Inc., 770 F.2d 1015, 226 USPQ 881 (Fed. Cir. 1985). Not every competing product that arguably falls within the scope of a patent is evidence of copying. Otherwise every infringement suit would automatically confirm the nonobviousness of the patent." *Iron Grip Barbell Co., Inc. v. USA Sports, Inc.*, 392 F.3d 1317, 1325 (Fed. Cir. 2004).

E. Patent Owner also cites the declaration of Mr. Hampton, which describes value of services, and argues that value of services shows strong evidence of commercial success of the claimed invention (see pages 25-26 of the response filed on 1/22/2013).

Although the cited declaration of Mr. Hampton states the number of jobs performed "using the invention of Amended Claims 1 and 8 of the '175 patent" and a large amount of revenues generated from the services, the declaration does not provide evidence to show that the services provided by Patent Owner correspond to the claimed process. Patent Owner bears the burden of demonstrating nexus between the objective evidence of nonobviousness and the claimed invention. *See* MPEP 716.03.

An affidavit or declaration attributing commercial success to a product or process "constructed according to the disclosure and claims of [the] patent application" or other equivalent language does not establish a nexus between the claimed invention and the commercial success because there is no evidence that the product or process which has been sold corresponds to the claimed invention, or that whatever commercial success may have occurred is attributable to the product or process defined by the

claims. *Ex parte Standish*, 10 USPQ2d 1454, 1458 (Bd. Pat. App. & Inter. 1988). Also, MPEP 716.03(a)

Patent Owner also fails to show that any commercial success of the services are due to the performing of the claimed process and are not the result of other factors, such as the result of heavy promotion/advertising or consumption by purchasers normally tied to applicant or assignee.

In considering evidence of commercial success, care should be taken to determine that the commercial success alleged is directly derived from the invention claimed, in a marketplace where the consumer is free to choose on the basis of objective principles, and that such success is not the result of heavy promotion or advertising, shift in advertising, consumption by purchasers normally tied to applicant or assignee, or other business events extraneous to the merits of the claimed invention, etc. *In re Mageli*, 470 F.2d 1380, 176 USPQ 305 (CCPA 1973) (conclusory statements or opinions that increased sales were due to the merits of the invention are entitled to little weight); *In re Noznick*, 478 F.2d 1260, 178 USPQ 43 (CCPA 1973).” Also see MPEP 716.03(b).

In addition, the revenues generated from the services provided in the declaration are also insufficient to show commercial success. Gross sales figures do not show commercial success absent evidence as to market share, *Cable Electric Products, Inc. v. Genmark, Inc.*, 770 F.2d 1015, 226 USPQ 881 (Fed. Cir. 1985), or as to the time period during which the product was sold, or as to what sales would normally be

expected in the market, *Ex parte Standish*, 10 USPQ2d 1454 (Bd. Pat. App. & Inter. 1988). Also see MPEP 716.03(b) IV.

Accordingly, for the reasons stated above, Patent Owner fails to establish a nexus between the rebuttal evidence and the claimed invention.

Further, as stated above, the cited references clearly disclose the claimed method as recited in claims 1-7, 9 and 11. The evidence of secondary considerations provided by Patent Owner is insufficient to overcome the obviousness rejections of record.

Evidences pertaining to secondary considerations must be taken into account whenever present; however, it does not necessarily control the obviousness conclusion. See, e.g., *Pfizer, Inc. v. Apotex, Inc.*, 480 F.3d 1348, 1372, 82 USPQ2d 1321, 1339 (Fed. Cir. 2007) ("the record establish [ed] such a strong case of obviousness" that allegedly unexpectedly superior results were ultimately insufficient to overcome obviousness conclusion); *Leapfrog Enterprises Inc. v. Fisher-Price Inc.*, 485 F.3d 1157, 1162, 82 USPQ2d 1687, 1692 (Fed. Cir. 2007)("given the strength of the *prima facie* obviousness showing, the evidence on secondary considerations was inadequate to overcome a final conclusion" of obviousness); and *Newell Cos., Inc. v. Kenney Mfg. Co.*, 864 F.2d 757, 768, 9 USPQ2d 1417, 1426 (Fed. Cir. 1988). Also see MPEP 2145.

***Response to Patent Owner's Arguments* filed on 9/16/2013**

In response to the ACP filed on 8/16/2013, Patent Owner presents the following additional main arguments.

1. Interpretation of Claims 1 and 11.

A. Patent Owner argues that the claims are limited to a hydraulic fracturing process. Patent Owner states that "[i]t appears that the Examiner may be using the preamble to 'trump' the amendment. Such reasoning would be inappropriate, because the preamble cannot be used to expand the scope of a claim." (See pages 2-4 of the response filed on 9/16/2013, emphasis in original).

Patent Owner mischaracterizes the Examiner's claim interpretation stated in the ACP mailed 8/16/2013. Claims 1 and 11 of the '175 patent recite a method for determining the extent of recovery of materials injected into an oil well. The recitation that "the material injected into the oil well is a material useful for hydraulically fracturing the oil well" describes the intended use of the injected material, i.e. the injected material can be used for hydraulically fracturing the oil well. However, the claims do not require that the injected material is used only for hydraulically fracturing process. Accordingly, the claims are not limited to a hydraulically fracturing method.

B. Patent Owner cites the Supplemental Technical Declarations of Thomas Hampton (paragraphs 7-14) and Gary Wooley (paragraphs 7-14) and argues that it is well known in the art that these materials (the materials useful for hydraulically fracturing) are useful only for hydraulic fracturing (page 4 of the response filed on 9/16/2013).

Both the Hampton Declaration (paragraphs 7-14) and the Wooley Declaration (paragraphs 7-14) discuss the difference between hydraulic fracturing fluids and drilling

fluids and state that hydraulic fracturing fluids are only used for hydraulic fracturing and drilling fluids are only for drilling. However, as stated above, the claims do not limit the injected material to be used only for hydraulic fracturing. The injected material as claimed can be any material that is useful for hydraulic fracturing. Materials useful as hydraulic fracturing fluids can also be useful for other purposes. For example, water is a material useful for hydraulically fracturing, e.g. useful as a carrier fluid. The '175 patent discloses the use of water as a hydraulic fracturing fluid (see the Example at cols. 6-7). However, water can also be useful for other processes, such as drilling and waterflooding. Accordingly, the recitation that “the material injected into the oil well is a material useful for hydraulically fracturing the oil well” does not further limit the claimed method to be a hydraulically fracturing method.

2. Rejection Based on Hinkel in View of Deans

A. Patent Owner argues that Deans is nonanalogous art and cannot be combined with Hinkel because Deans is directed to waterflooding, a completely different field of endeavor than the hydraulic fracturing of the present claims. Water flooding operations are never mentioned in the '175 patent. Water flooding and reservoir fluid flow studies are completely different operations from hydraulic fracturing (pages 9-10 of the response filed on 9/16/2013). Patent Owner also argues that Deans is not pertinent to the problem faced by the inventor. Patent Owner states that the contrast between hydraulic fracturing and waterflooding is such that any solutions found in the waterflooding arts have no relevance to the problems faced by those in the hydraulic

fracturing arts. Further, Patent Owner cites a document downloaded from the website FracFocus.org and states that hydraulic fracturing is not a "drilling process" (pages 11-12 of the response filed on 9/16/2013).

As stated in MPEP 2141.01(a):

> "Under the correct analysis, any need or problem known in the field of endeavor at the time of the invention and addressed by the patent [or application at issue] can provide a reason for combining the elements in the manner claimed." *KSR International Co. v. Teleflex Inc.,* 550 U.S. ** > 398,420, 82 USPQ2d 1385, 1397 (2007). "This does not require that the reference be from the same field of endeavor as the claimed invention, in light of the Supreme Court's instruction that '[w]hen a work is available in one field of endeavor, design incentives and other market forces can prompt variations of it, either in the same field or a different one.' KSR Int'l Co. v. Teleflex Inc., 550 U.S. 398, 417 (2007). Rather, a reference is analogous art to the claimed invention if: (1) the reference is from the same field of endeavor as the claimed invention (even if it addresses a different problem); or (2) the reference is reasonably pertinent to the problem faced by the inventor (even if it is not in the same field of endeavor as the claimed invention). *See Bigio*, 381 F.3d at 1325." (Emphasis added).

Accordingly, a reference is analogous art to the claimed invention if it meets one of the requirements as stated above in MPEP 2141.01(a).

Deans is analogous art because Deans is from the same field of endeavor as the claimed invention. The claims of the ‘175 patent recite a method for determining the extent of recovery of materials injected into an oil well. The '175 patent describes that the inventive method can be used in a drilling, fracturing or any other operation requiring the injection of materials into an oil well (col. 1, lines 57-64 and col. 3, lines 29-34). The drilling fluid can be “drilling muds” (col. 3, lines 21-22). The ‘175 patent also states that the inventive method can be used in a well “for water flooding in secondary recovery operations in oil and gas production” (col. 2, lines 17-20, emphasis added). The '175 patent further states that “[t]he tracers useful for the inventive method include any

known to those ordinary skill in the art of using chemical tracers in oil and gas operations to be useful" (col. 3, lines 29-60). Accordingly, the claimed invention of the '175 patent is directed to a method of using tracer for determining the extent of recovery of materials injected into an oil well for field operations such as drilling, fracturing and water flooding.

Both the cited references, Hinkel and Deans, teach the method of using tracers to determine the recovery of injected fluids in oil and gas field operations. Hinkel teaches the use of tracers in a hydraulic fracturing process. Deans teaches the use of tracers in a water flooding process. Both processes are field operations requiring the injection of materials into an oil well. Accordingly, both processes are in the same field of endeavor as the claimed invention recited in the '175 patent.

Further, even if the water flooding process described in Deans is a different operation from hydraulic fracturing process as argued by Patent Owner, Deans is also pertinent to the particular problems/needs faced by Patent Owner at the time of the invention of the '175 patent. The '175 patent discusses the need/desire of using an inexpensive and environmentally benign method in oil and gas productions to determine the recovery of the injected material after a drilling, fracturing or any other operation requiring the injection of material into an oil well (col. 1, lines 57-63). Deans teaches the use of tracer concentration profiles in the produced fluid to determine /calculate the amount of injected fluid recovered. Specifically, Deans teaches that the concentration of the tracer in the produced fluid can be measured and used for material balance purposes to determine the fluid flow characteristics including using the tracer

concentration profile as a basis to determine the amount of the injected fluid produced (recovered). Deans clearly describes a tracer study which is pertinent to the particular problems/need faced by Patent Owner. Accordingly, Deans is analogous art to the claimed invention of the '175 patent.

B. Patent Owner argues that engineers and geologists who design water flooding operations or fluid flow studies are not the same people who design fracturing operations. Considering waterflooding and hydraulic fracturing as analogous simply ignores the technical and commercial differences between these two technologies (page 10 of the response filed on 9/16/2013).

Patent Owner's arguments are not persuasive for the same reasons as stated above in section 2A. The determination of analogous art is not based on whether the waterflooding and hydraulic fracturing operations are designed by the same or different engineers and geologists. As stated above in section 2A, Deans is analogous art because (1) Deans is from the same field of endeavor as the claimed invention and (2) Deans is also pertinent to the particular problems/needs faced by Patent Owner at the time of the invention of the '175 patent.

Further, as also argued by Requester (pages 17-18 of the comments filed on 10/7/2013):

> In further response to the contention of the Patent Owner regarding the isolation of fracturing engineers and their asserted lack of knowledge and awareness concerning other oil-field operations, Mr. Alfred Jennings explains in ¶¶ 8-11 of his Supplemental Declaration (Requester's Exhibit G) concerning drilling, cementing, perforating, fracturing, flooding, and other stimulation and

enhanced recovery operations that:

> Depending upon the size of the oil and gas operating company, a staff of operations engineers, production engineers, and well completions engineers may handle every aspect of the well completions described above. In small companies, only a few engineers may be available to handle the myriad of operations necessary to produce oil and gas. Regardless of the number of engineers involved in a particular field, team meetings, technical presentations, etc. are periodically held to provide information and to discuss ideas concerning the various aspects of oil and gas well operations.
>
> Since fluids not commonly found in producing formations must be used during many phases of well operations, the recovery and accounting of fluid volumes used are inherent in many of the well completions operations. This is true with drilling, cementing, perforating, workovers, hydraulic fracturing and other stimulation operations. It is also important with secondary recovery operations such as waterflooding, because of formation heterogeneities where certain higher permeability zones can cause premature water breakthrough in producing wells.
>
> Rather than being separate technologies handled by completely different sets of professionals, oftentimes well issues will be discussed in group or team format to draw from the experiences and knowledge of others within the company. For example, hydraulic fracturing is often used in water injection wells to improve injection rates. Fracturing can also be used in special applications to improve injection well profiles to improve sweep efficiency in lower permeability intervals. Tracers are frequently used to measure injection profiles in water injection wells.
>
> Tracer technology borrowed from waterflooding is also employed in hydraulic fracturing applications in parallel laterals where one lateral represents a producing well and tracers may be injected during fracturing of a second (offset) parallel lateral. The reason for injecting tracers into the newly fractured well is to determine fracture to fracture interference with the producing well.

C. Patent Owner also argues that the tracer arts are too unpredictable to justify combining Hinkel with Deans because there are no “finite” or limited solutions available to those skilled in the art. Patent Owner also refers to the cited references

and argues that the present record here provides ample evidence that tracers have been put to a multitude of uses--many of which required extensive experimentation to implement (pages 12-16 of the response filed on 9/16/2013).

Patent Owner’s arguments are not persuasive. The cited references, Hinkel, Deans and Hall, disclose that tracers can be used in field operations such as fracturing (Hinkel), waterflooding (Deans) and drilling (Hall). The '175 patent also describes that the inventive method can be put to the same “multitude of uses”, i.e., drilling, fracturing, and water flooding. In fact, the ‘175 patent discloses that the inventive method can be used for other processes in addition to the three processes stated above. The '175 patent states that the inventive method can be used in a drilling, fracturing or any other operation requiring the injection of materials into an oil well (col. 1 lines 57-64 and col. 3, lines 29-34). The '175 patent also describes that the drilling fluid can be “drilling muds” (col. 3, lines 21-22) and the inventive method can be used in a well “for water flooding in secondary recovery operations in oil and gas production” (col. 2, lines 17-20). Accordingly, hydraulic fracturing, waterflooding and drilling processes are all within the scope of the claimed invention of the '175 patent. Contrary to Patent Owner's arguments, there is no discussion in the '175 patent that the tracer arts are too unpredictable to the “multitude of uses”. The '175 patent states that “[t]he tracers useful for the inventive method include any known to those ordinary skill in the art of using chemical tracers in oil and gas operations to be useful “(col. 3, lines 29-60, emphasis added).

Patent Owner's arguments with respect to the individual cited reference (see pages 12-16 of the response filed on 9/16/2013) are also not persuasive for the following reasons.

Deans

a) Patent Owner argues that the injection rate and pressure in Deans are intentionally kept low in order to avoid fracturing the formation by exceeding the formation fracture strength. Patent Owner further argues the concentration of tracer in the injected fluid of Deans ranges from about one-half to two percent by volume and is a much higher tracer concentration than the invention of the ‘175 patent, which describes the use of a concentration of 1000 parts per million.

Deans does not intentionally keep the injection rate and pressure low in order to avoid fracturing the formation. Rather, Deans discloses that “the injection rate is not a significant factor in the analysis of the results because the rate of immobile fluid adsorption by the injected fluid is relatively independent of the injected fluid flow rate. The production rate should not significantly change the formation fluid pressure.” Deans further states that “the injection and production rates of the fluids can be established by those skilled in the art by taking into account such factors as the reservoir conditions and injection and production facilities” (col. 7, lines 36-47).

As also argued by Requester (page 9 of the comments filed on 10/7/2013):

> In other words, the teaching of Deans et al. concerning tracer studies is that a tracer study is merely a tool for analyzing the results of an oilfeld operation. Deans et al. also make clear at column 7, lines 43-45 that, regardless of the preferred injection rates for water flooding, the actual injection rate used in the practice of the process is not a significant factor in the analysis of the results.

With respect to the concentration range of the tracer in the injected fluid, Patent Owner's arguments are not commensurate with the scope of claims 1-4, 9 and 11 since these claims do not require the specific concentration as argued by Patent Owner. With respect to the remaining claims, claim 5 recites that the tracer is present in the injected mixture at a concentration of at least about 1 part per trillion. Claim 6 depends on claim 5. Claim 6 recites that the tracer is present in the injected mixture at a concentration of less than or equal to 10,000 ppm. Deans discloses, as a matter of economics, that the concentration of the tracer in the injected fluid ranged from about one half to two percent by volume (5000 - 20,000 ppm) (col. 7, lines 33-35). The tracer concentration disclosed in Deans is in the same range as recited in claims 5-6 of the '175 patent. Further, Deans states that the concentration of the tracer is determined based on economic consideration. Accordingly, the teachings of Deans would have led one skilled in the art to use lower concentration in order to reduce the cost. Claim 7 recites that the concentration of the tracer is from 100 ppt to about 100 ppm. As stated above in the Claim Rejections section, the combination of Hinkel, Deans and one of the additional cited references, Chen, Hoots or Greenkorn, teaches the concentration range recited in claim 7.

b) Patent Owner also argues that hydraulic fracturing is most commonly applied to unconventional reservoirs such as shale formations and is not intended to sweep an area of the reservoir as waterflooding does. Instead the injected fracture fluid returns to the surface in the same wellbore into which it was injected.

Patent Owner's arguments are not commensurate with the scope of the claims since the claims of the '175 patent do not require that the claimed method is a hydraulic fracturing.

Patent Owner's arguments are also not persuasive for the same reasons as stated above in section 2A. Specifically, as stated above, the claimed invention of the '175 patent is directed to a method of using a tracer for determining the extent of recovery of materials injected into an oil well for field operations such as drilling, fracturing and water flooding. Both waterflooding and hydraulic fracturing are within the scope of the claimed invention of the '175 patent.

Additionally, as argued by Requester (page 6 of the comments filed on 10/7/2013):

> Contrary to the assertions of the Patent Owner and its expert, the Hinkel et al. procedure is used in both conventional (high permeability) and unconventional (low permeability) formations. As stated by Hinkel et al. at Column 2, lines 26-43:
>
> > [H]ydraulic fracturing is a common means to stimulate hydrocarbon production in low permeability formations**. <u>In addition, fracturing has also been used to stimulate production in high permeability formations.</u>** Obviously, if fracturing is desirable in a particular instance, then it is also desirable, generally speaking, to create as large (i.e., long) a fracture zone as possible--e.g., a larger fracture means an enlarged towpath from the hydrocarbon migrating towards the wellbore and to the surface.
>
> Moreover, as further evidence of the importance of the Hinkel et al. process for conventional (high permeability) formations, Hinkel et al. also state at Column 4, lines 25-37 that:
>
> > [I]t is desirable to remove the fracturing fluid from the fracture--its presence in the fracture is deleterious, since it plugs the fracture and therefore impedes the flow of hydrocarbon. **<u>This effect is naturally</u>**

> **greater in high permeability formations, since the fluid can readily fill the (larger) void spaces**. (Emphasis in original).

With respect to the argument that "the injected fracture fluid returns to the surface in the same wellbore into which it was injected," Requester states the following (pages 10-11 of the comments filed on 10/7/2013):

> Concerning yet another misstatement by the Patent Owner regarding Deans et al., the Patent Owner argues on pages 12-13 of its Response that Deans et al. is distinguishable from hydraulic fracturing because fracturing fluid is recovered from the same wellbore into which it was injected whereas the Deans et al. fluid is not. However, contrary to the Patent Owner's contention, the Abstract of the Deans et al. patent states that: "The injected fluid is then preferably produced from the formation by means of the injection well."
>
> Moreover, not only is the Patent Owner's statement incorrect in regard to the actual teaching of Deans et al., but the Patent Owner is also incorrect in asserting that a fracturing fluid will always be recovered from the same well into which it was injected. For example, as explained in ¶ 11 of the Supplemental Declaration of Alfred Jennings (Requester's Exhibit G):
>
>> Tracer technology borrowed from waterflooding is also employed in hydraulic fracturing applications in parallel laterals where one lateral represents a producing well and tracers may be injected during fracturing of a second (offset) parallel lateral. The reason for injecting tracers into the newly fractured well is to determine fracture to fracture interference with the producing well.

c) Patent Owner also argues that the Deans method is not described as being capable of making a distinction as to which fluid from a particular region in a fracture is the first to be recovered from a well. One skilled in the art would understand that Deans has no disclosure or suggestion that it can be used to verify differential mobility of fluids in a well as required by the tracer study described in Hinkel.

Again, Patent Owner's argument is not commensurate with the scope of the claims since the claims of the '175 patent do not require that the claimed method to

"make a distinction as to which fluid from a particular region in a fracture is the first to be recovered from a well."

Patent Owner's argument is also inconsistent with the disclosure of the '175 patent. The '175 patent describes that the inventive method can be used in a drilling, fracturing or any other operation requiring the injection of materials into an oil well (col. 1 lines 57-64 and col. 3, lines 29-34). The '175 patent also states that "[t]he tracers useful for the inventive method include any known to those ordinary skill in the art of using chemical tracers in oil and gas operations to be useful" (col. 3, lines 29-60). Accordingly, the tracer study described in the '175 patent can be used in field operations including the hydraulic fracturing described in Hinkel and the waterflooding described in Deans.

Further, Patent Owner's argument is unpersuasive with respect to the teachings of Hinkel and Deans.

Hinkel discloses a fracture clean-up process which involves recovering the injected fluid from the fracture (col. 3, lines 9-19 and Examples). Hinkel describes that the method for fracturing comprises a suite of breakers or a single breaker at varying concentrations, to induce a mobility gradient, such that fracturing fluid near a fracture tip has a higher differential mobility (DM) than fracturing fluid near the well bore (Claim 1). In Example 4, Hinkel states that:

> The effectiveness of DM treatments are simple to verify in actual field applications. For instance, a tracer study can be performed whereby small amounts of tracers are added to different stages of the fracturing fluid. If the method of the present Invention is operable then the tracer study should indicate the first fluid injected flows back sooner compared with the remainder of the fluid, compared with conventional treatments.

As indicated above, the tracer study described in Hinkel is simply a tool that is intended to be used to verify the effectiveness of the fracturing process in actual field operations. Hinkel describes that the tracer study is performed by (1) adding small amounts of tracer to different stages of the fracturing fluid and (2) analyzing the recovered fluid to determine the effectiveness of the fracturing process. Hinkel does not design a new tracer process. Using a tracer study to verify the recovery of injected fluids in a field operation is well known in the art. Hinkel simply uses the known tracer study as a tool to determine the effectiveness of the fracturing process. Similarly, Deans also discloses a method of using a tracer study as a tool for analyzing a process in field operations. Specifically, Deans describes that the tracer study uses the tracer concentration profile as a basis to determine the amount of the injected fluid produced (recovered). Accordingly, it would have been obvious to one of ordinary skill in the art, seeking to further improve the tracer study used in Hinkel, to apply the tracer study suggested by Deans in order to determine/calculate the recovery of the injected fluids in Hinkel's process. In other words, using the tracer concentration profile method as suggested by Deans in Hinkel's fracturing process to determine the amount of the injected fluid recovered from different stages of the fracturing fluid ("differential mobility of the fluids") would have been obvious to one of ordinary skill in the art.

Further, as also argued by Requester (pages 10-11 of the comments filed on 10/7/2013):

> In addition, on pages 13 and 16, the Patent Owner attempts to argue that Deans et al. and Hall are not compatible with hydraulic fracturing because they are not described as being capable of making a distinction as to which fluid came

> from a particular region. However, this is not a requirement of any of the claims of the '175 Patent. Moreover, as will be discussed more fully below, accomplishing the task of distinguishing between stages is already explained by the Hinkel et al. reference which teaches that the result is obtained by putting a different tracer in each stage. In addition, many of the other references of record, particularly those cited against tracer claims 2-7 of the '175 Patent, disclose numerous alternative tracers which are separately detectable, including the Bowman reference which states in the Abstract thereof that: "These latter three fluorobenzoates show promise as laboratory and field tracers of soil water, particularly where multiple tracing tests or totally exotic tracers are required." (Emphasis in original).

Hinkel

Patent Owner argues that Hinkel discloses various fluids be injected into the formation at a rate of 45 barrels per minute (approximately 7 m^3 per minute) to create a fracture zone. This injection rate is much higher than the injection rates typically used for water flooding or fluid flow applications. Hinkel is silent regarding the amount and type of tracer used, and mentions tracers only in passing as a way of verifying that the fluid from the fracture tips is flowing back sooner than the remainder of the fluid.

Patent Owner's argument with respect to the injection rate is not commensurate with the scope of the claims. The instant claims do not require a specific injection rate nor does the specification of the '175 patent discuss any injection rate that is critical/important to the inventive method of using tracer to determine the extent of recovery of the materials injected into an oil well.

Patent Owner's argument is also inconsistent with the disclosure of the '175 patent. The '175 patent describes that the inventive method can be used in a drilling, fracturing or any other operation requiring the injection of materials into an oil well (col. 1, lines 57-64 and col. 3, lines 29-34). Accordingly, both the hydraulic fracturing

process described in Hinkel and the waterflooding process described in Deans are within the scope of the claimed invention of the '175 patent.

Further, in response to the argument that Hinkel is silent regarding the amount and type of tracer used, Patent Owner cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.,* 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). In this case, as stated above in the Claim Rejections section, the combination of the cited references teaches the amount and type of the tracer used. For example, the combination of Hinkel and Deans teaches the amount of the tracer as recited in claims 5-6. The combination of Hinkel, Deans and Dugstad teaches the amount and type of tracer as recited in claims 2-4, 9 and 11. The combination of Hinkel, Deans and one of the additional cited references, Chen, Hoots, or Greenkorn, teaches the amount of tracer as recited in claims 5-7.

Dugstad

a) Patent Owner argues that Dugstad discusses the use of various tracers in connection with a Water-Alternating-Gas ("WAG") application. Among other data gathered by Dugstad was the "breakthrough time" between the tracer injection and the time when the first sample containing that tracer was collected. Breakthrough time for the various tracers varied from 37 days to nearly 5 years. These lengthy "breakthrough times" are not seen in hydraulic fracturing operations, where the recovery of fracturing fluids typically begins very soon after the start of production. Patent Owner also argues that tracers are suggested to test the purpose of the Dugstad invention, which is to

change the mobility of trapped oil as a result of injecting gas such as carbon dioxide. Flushing a conventional reservoir according to the teachings of Dugstad is very different from hydraulic fracturing where injected fracture fluid returns to the surface through the same wellbore into which it was injected.

Again, Patent Owner's argument is not commensurate with the scope of the claims since the claims of the '175 patent do not require a quick recovery time or a short breakthrough time nor does the specification of the ‘175 patent discuss any recovery time or breakthrough time that is critical/important to the inventive method of using tracer to determine the extent of recovery of the materials injected into an oil well.

Patent Owner’s argument is also inconsistent with the disclosure of the '175 patent. The ‘175 patent describes that the inventive method can be used in a drilling, fracturing or any other operation requiring the injection of materials into an oil well (col. 1, lines 57- 64 and col. 3, lines 29-34). Accordingly, the processes described in Hinkel, Deans and Dugstad are all within the scope of the claimed invention of the '175 patent.

With respect to the argument that the injected fracture fluid returns to the surface through the same wellbore into which is was injected, Patent Owner’s argument is not persuasive for the same reasons as stated above with respect to **Deans** under section b).

Chen

Patent Owner argues that Chen teaches improved tracers for use in determining fluid flow patterns in subterranean formations. Fluid is injected into the formation slowly, at a rate of approximately 2.4 ml/hour. The fluid is injected into an injection well, and

then samples are taken from one or more production wells. Col. 1, lines 60-67. Slow (low pressure to avoid fracture) injection of fluid to sweep a conventional reservoir is very different than high pressure injection for the purpose of causing a fracture. Fracture fluid does not travel through the formation to be produced from a different well than it was injected (pages 14-15 of the response filed on 9/16/2013).

Patent Owner's arguments are unpersuasive for the same reasons as stated above with respect to **Hinkel**. Specifically, the process disclosed in Chen is within the scope of the claimed invention of the '175 patent. Patent Owner's argument with respect to the injection rate described in Chen is not commensurate with the scope of the claims since the claims of the '175 patent do not require a specific injection rate. In addition, there is no discussion in Chen that the injected rate is set slowly to prevent fracture.

With respect to the argument that fracture fluid does not travel through the formation to be produced from a different well than it was injected, Patent Owner's argument is not persuasive for the same reasons as stated above with respect to **Deans** under section b).

Hoots

Patent Owner argues that Hoots teaches the use of fluorescent tracers in a liquid system to which a treating chemical is added. The fluorescent tracers are used in very low concentrates of around 200 ppm to parts per trillion.

Patent Owner's argument is not persuasive for the same reasons as stated above with respect to **Deans** under section a). Specifically, only claims 5-6 require that

the tracer is present in the mixture at a specific concentration. Claim 5 recites that the tracer is present in the injected mixture at a concentration of at least about 1 part per trillion. Claim 6 depends on claim 5. Claim 6 recites that the tracer is present in the injected mixture at a concentration of less than or equal to 10,000 ppm. Deans discloses, as a matter of economics, that the concentration of the tracer in the injected fluid ranged from about one half to two percent by volume (5000 - 20,000 ppm) (col. 7, lines 33-35). The tracer concentration disclosed in Deans is in the same range as recited in claims 5-6. Further, Deans states that the concentration of the tracer is determined based on economic consideration. Accordingly, the teachings of Deans would have led one skilled in the art to use lower concentration in order to reduce the cost. Claim 7 recites that the concentration of the tracer is from 100 ppt to about 100 ppm. As stated above in the Claim Rejections section, the combination of Hinkel, Deans and Hoots teaches the concentration range recited in claim 7.

Teasdale

Patent Owner argues that Teasdale teaches the use of tracers to determine the fluid drift rate within a reservoir. A discrete slug of fluid with tracer is slowly injected (to prevent fracture) into the formation at the rate of about 32 m^3 per day. By contrast fracture fluid is injected at high pressure to create a fracture.

Patent Owner's arguments are unpersuasive for the same reasons as stated above with respect to **Hinkel**. Specifically, the process disclosed in Teasdale is within the scope of the claimed invention of the ‘175 patent. Patent Owner’s argument with respect to the injection rate described in Teasdale is not commensurate with the scope

of the claims since the claims of the ‘175 patent do not require a specific injection rate. In addition, there is no discussion in Teasdale that the injected rate is set under low pressure to avoid fracture.

Greenkorn

Patent Owner argues that Greenkorn teaches the selection of specific tracers to locate flow paths through a reservoir for water flooding applications. In a field test, the fluid was slowly injected into the well at a rate of approximately 1.5 m^3 per day. There are differences between waterflooding at low pressure to avoid fracture and injecting fracture fluids at high pressure to cause fractures.

Again, Patent Owner's arguments are unpersuasive for the same reasons as stated above with respect to **Hinkel**. Specifically, the process disclosed in Greenkorn is within the scope of the claimed invention of the ‘175 patent. Patent Owner’s argument with respect to the injection rate described in Greenkorn is not commensurate with the scope of the claims since the claims of the ‘175 patent do not require a specific injection rate. In addition, there is no discussion in Greenkorn that the injected rate is set under low pressure to avoid fracture.

Bowman

Patent Owner argues that Bowman teaches the selection of specific tracers for use in soil water studies. One of the tracers under consideration, SCN-, was of interest because it had previously been successfully used to follow water movement in oil-bearing formations. Page 987. However, Bowman concluded that SCN- was "not a suitable soil water tracer even for short-term studies, due to rapid chemical and/or

biological transformation." Page 992. This demonstrates that a tracer that is useful for one application may not be useful for other applications (page 16 of the response filed on 9/16/2013).

Patent Owner’s arguments are not commensurate with the scope of claims 1 and 5-7, 9 and 11 since these claims do not recite any specific tracer.

With respect to claims 2-4 and 11, Patent Owner's arguments are not persuasive. Bowman clearly teaches the benefits of using the specific tracer as claimed in similar environments. One skilled in the art, searching for a suitable trace chemical for use in the injected fluids disclosed in Hinkel and Deans, would select the tracers, such as fluorinated benzoic acids, as suggested by Bowman, because these tracers exhibit highly desirable performance and characteristics including resistance to chemical and microbial degradation (see Bowman, page 988, 1st column).

Further, Patent Owner’s argument that “a tracer that is useful for one application may not be useful for other applications” is inconsistent with the disclosure of the '175 patent. The ‘175 patent describes that the inventive method can be used in a drilling, fracturing or any other operation requiring the injection of materials into an oil well (col. 1 lines 57-64 and col. 3, lines 29-34). Contrary to Patent Owner's argument, the '175 patent clearly indicates that “[t]he tracers useful for the inventive method include any known to those ordinary skill in the art of using chemical tracers in oil and gas operations to be useful“ (col. 3, lines 29-60 emphasis added).

Hall

Patent Owner argues that Hall relates to using tracers to monitor the circulation of drilling mud in a well during a drilling operation. The tracer is injected into the drilling mud in discrete doses. This differs from hydraulic fracturing operations, wherein the tracer is typically admixed continuously into the stream of injected fracturing fluid. The residence time density function of the tracer is calculated in order to characterize the circulation of fluid in the wellbore. The Hall method is not described as being capable of making a distinction as to which fluid from a particular region in a well is the first to be recovered from a well. Instead, the Hall method is described as only providing information regarding mud circulation. Hall has no disclosure or suggestion that it can be used to verify differential mobility of fluids in a well as required by the tracer study described in Hinkel (page 16 of the response filed on 9/16/2013).

Patent Owner's arguments are not commensurate with the scope of the claims since the claims of the '175 patent do not require that the claimed method is a hydraulic fracturing process or a process for verifying differential mobility of fluids in a well. The claims of the '175 patent recite a method of using a tracer for determining the extent of recovery of materials injected into an oil well from any field operations (e.g. hydraulic fracturing, drilling and waterflooding).

Patent Owner's argument are also inconsistent with the disclosure of the '175 patent. The '175 patent describes that the inventive method can be used in a drilling, fracturing or any other operation requiring the injection of materials into an oil well (col. 1 lines 57-64 and col. 3, lines 29-34). The drilling fluid can be "drilling muds." The '175 patent also states that "[t]he tracers useful for the inventive method include any known

to those ordinary skill in the art of using chemical tracers in oil and gas operations to be useful" (col. 3, lines 29-60). Accordingly, both hydraulic fracturing process disclosed in Hinkel and the drilling process disclosed in Hall are within the scope of the claimed invention recited in the '175 patent.

Further, Patent Owner's arguments are also unpersuasive with respect to the teachings of Hinkel and Hall.

Hinkel discloses a fracture clean-up process which involves recovering the injected fluid from the fracture (col. 3, lines 9-19 and Examples). Hinkel describes that the method for fracturing comprising a suite of breakers or a single breaker at varying concentrations, to induce a mobility gradient, such that fracturing fluid near a fracture tip has a higher differential mobility (DM) than fracturing fluid near the well bore (Claim 1). In the Example 4, Hinkel states that:

> The effectiveness of DM treatments are simple to verify in actual field applications. For instance, a tracer study can be performed whereby small amounts of tracers are added to different stages of the fracturing fluid. If the method of the present Invention is operable then the tracer study should indicate the first fluid injected flows back sooner compared with the remainder of the fluid, compared with conventional treatments.

As indicated above, the tracer study described in Hinkel is simply a tool that is intended to be used to verify the effectiveness of the fracturing process in actual field operations. Hinkel describes that the tracer study is performed by (1) adding small amounts of tracer to different stages of the fracturing fluid and (2) analyzing the recovered fluid to determine the effectiveness of the fracturing process. Hinkel does not design a new tracer process. Using a tracer study to verify the recovery of injected fluids in a field operation is well known in the art. Hinkel simply uses the known tracer

study as a tool to determine the effectiveness of the fracturing process. Similarly, Hall also teaches a tracer study as a tool for analyzing a process in field operations. Hall teaches a method for monitoring drilling mud circulation in a well wherein a tracer is added to the aqueous drilling mud. More specifically, Hall describes a preferred operation involves injecting a quantity of tracer into the mud inlet at the surface; detecting quantitatively the time variation of the tracer concentration as it returns to the surface; processing the tracer return concentration data to obtain a residence time distribution for the circulation; using the time distribution to obtain information on the circulation. Accordingly, it would have been obvious to one of ordinary skill in the art, seeking to further improve the tracer study used in Hinkel, to apply the tracer technique suggested by Hall in order to determine/calculate the recovery of the injected fluids in Hinkel's process. In other words, using the tracer concentration time distribution method as suggested by Hall in Hinkel's fracturing process to determine the extent of the injected fluid recovered from different stages of the fracturing fluid ("differential mobility of the fluids") would have been obvious to one of ordinary skill in the art.

As also argued by Requester (pages 10-11 of the comments filed on 10/7/2013):

> In addition, on pages 13 and 16, the Patent Owner attempts to argue that Deans et al. and Hall are not compatible with hydraulic fracturing because they are not described as being capable of making a distinction as to which fluid came from a particular region. However, this is not a requirement of any of the claims of the '175 Patent. Moreover, as will be discussed more fully below, accomplishing the task of distinguishing between stages is already explained by the Hinkel et al. reference which teaches that the result is obtained by putting a different tracer in each stage. In addition, many of the other references of record, particularly those cited against tracer claims 2-7 of the '175 Patent, disclose numerous alternative tracers which are separately detectable, including the Bowman reference which states in the Abstract thereof that: "These latter three fluorobenzoates show promise as laboratory and field tracers of soil water,

> particularly where multiple tracing tests or totally exotic tracers are required." (Emphasis in original).

D. Patent Owner states that the solutions offered by tracer studies vary on almost a case-by-case basis. The fact that a particular tracer study may have provided a solution for one type of application--for example, assessing fluid flow through a reservoir--has no bearing on whether that solution would predictably and with a reasonable expectation of success solve a problem in the hydraulic fracturing arts (pages 16-17 of the response filed on 9/16/2013).

Patent Owner's arguments are not persuasive for the same reasons as stated above in section 2C. As stated above, the cited references show that the tracer studies can be used in various applications (drilling, fracturing, waterflooding, etc.) to provide the same solution, i.e. determining the extent of the recovery of materials injected into an oil well. This is also confirmed by the disclosure of the '175 patent. The '175 patent states that the inventive method can be used in a drilling, fracturing or any other operation requiring the injection of materials into an oil well and the tracers useful for the inventive method can be any chemical tracers known to be useful in oil and gas operations.

Additionally, as stated above in the Claim Rejections section, all the claimed elements were known in the prior art and one skilled in the art could have combine the elements as claimed by known methods with no change in their respective functions, i.e. using the tracer for determining the extent of recovery of materials injected into an oil well, and the combination would have yielded nothing more than predictable results

to one of ordinary skill in the art. *KSR International Co. v. Teleflex Inc.*, 550 U.S. ___, ___, 82 USPQ2d 1385, 1395 (2007). Also see MPEP2143.02. Accordingly, the teachings of the prior art clearly provide a sufficient basis for a reasonable expectation of success.

E. Patent Owner also argues that the Examiner, in making this combination of references, is engaging in mere "picking and choosing" in hindsight. This is in marked contrast to the requirement that the Examiner must combine known options into a finite number of identified predictable solutions as is required under KSR Int'l Co. v. Teleflex Inc., 550 U.S. 398,421 (2007)) (pages 17-18 of the response filed on 9/16/2013).

Patent Owner’s arguments are not persuasive. The claim rejections stated above are not based on mere “picking and choosing” in hindsight as argued by Patent Owner. Rather, the claim rejections are based on applying a known technique to a known method to improve methods or products in the same way or yield predictable results. *KSR International Co. v. Teleflex Inc.*, 550 U.S. ___, ___, 82 USPQ2d 1385, 1395-97 (2007). In the rejection of the independent claims based on Hinkel in view of Deans, the prima facie case of obviousness is established based on applying the known tracer study disclosed in Deans to Hinkel to further improve the tracer study in Hinkel’s process. Similarly, in the rejection of the independent claims based on Hinkel in view of Hall, Hall also provides a known tracer technique which would have been obvious to one of skill in the art to use for improving the tracer study disclosed in Hinkel. In the

rejections of the depending claims, each of the additional references further provides a known predictable solution to the process disclosed in Hinkel in view of Deans or Hinkel in view of Hall. Accordingly, the claim rejections clearly meet the prima facie case of obviousness requirements under KSR.

F. Patent Owner also argues that modifying Hinkel with Deans renders Hinkel unsatisfactory for its intended purpose (pages 18-19 of the response filed on 9/16/2013). Patent Owner states that:

> The intended purpose of the tracer study in Hinkel is to determine whether or not the fluid in the distal end of a fracture is the first fluid that is recovered. However, the tracer method of Deans is only used to determine fluid drift, fluid mobility, and the volume of fluid that has been recovered from the well (Declaration of Gary Wooley, Paragraph 17(a)). The Deans method is not described as being capable of making a distinction as to which fluid from a particular region in a fracture is the first to be recovered from a well (Declaration of Gary Wooley, Paragraph 0000). Instead, the Deans method is described as only providing an aggregate indication as to how much fluid has been recovers [sic] regardless of which location in the well that fluid has resided (Declaration of Gary Wooley, Paragraph 17(a)). Indeed, Deans has no disclosure or suggestion that it can be used to verify differential mobility in a well (Declaration of Gary Wooley, Paragraph 17(a)).

Patent Owner's arguments are not persuasive for the same reasons as stated above in section 2C with respect to **Hinkel** and **Deans**.

3. Rejection Based on Hinkel in View of Hall

Patent Owner argues the following (page 20 of the response filed on 9/16/2013):

> As discussed above, the intended purpose of the tracer study in Hinkel is to determine whether or not the fluid in the distal end of a fracture is the first fluid that is recovered. However, the tracer method of Hall is only used to determine how long a fluid has resided in a well (Declaration of Gary Wooley, Paragraph

> 17(i)). The Hall method is not described as being capable of making a distinction as to which fluid from a particular region in a well is the first to be recovered from a well (Declaration of Gary Wooley, Paragraph 17(i)). Instead, the Hall method is described as only providing information regarding mud circulation (Declaration of Gary Wooley, Paragraph 17(i)). Hall has no disclosure or suggestion that it can be used to verify differential mobility of fluids in a well (Declaration of Gary Wooley, Paragraph 17(i)).
>
> The only reason that Hinkel proposes a tracer study is to verify the differential mobility fracturing technique. Hall is unsatisfactory for such a use. Because the Hall tracer method is "unsatisfactory for its intended purpose" of verifying differential mobility, there is no suggestion or motivation to make the proposed modification. Accordingly, the Hinkel and Hall combination cannot be the basis of a prima facie case of obviousness of the present claims.

Patent Owner's arguments are not persuasive for the same reasons as stated above in section 2C with respect to **Hall**.

4. Secondary Consideration

A. Patent Owner argues that "it appears that the Examiner is requiring that a nexus be established between the pending claims and the commercial service strictly with the commercial brochure. As the Examiner is no doubt aware, there is no requirement that brochures for "SERVICES" be marked with patent numbers. The purpose of the brochure is not to instruct the public on how to perform the claimed invention but rather to market the services which are within the scope of the claims." (Pages 33-34 of the response filed on 9/16/2013).

Patent Owner appears to acknowledge that the nexus between the pending claims and the commercial service cannot be established based on the commercial brochure. In the previous response filed on 1/22/2013, Patent Owner relied on the commercial brochure filed with Mr. Hampton's declaration as evidence to show that a

nexus exists between the pending claims and its commercial service. Patent Owner stated that Mr. Hampton (in his declaration) demonstrated a correlation (nexus) between the elements of the combination of original patented claims 1 and 8 and the commercial process known as SPECTRAGHEM® as evidenced by the brochure (see pages 20-22 of the response filed on 1/22/2013). Patent Owner now argues that the purpose of the brochure is not to instruct the public on how to perform the claimed invention but rather to market the services which are within the scope of the claims. However, as stated in the ACP filed on 8/16/2013 (page 35-37), the brochure alone does not support that the SPECTRAGHEM® services are within the scope of the claims.

Further, Patent Owner cites the Supplemental Declaration of Mr. Hampton and argues the following:

> Turing specifically to the Supplemental Declaration of Mr. Hampton, each of the Examiner's objections as recited in the ACP were addressed. Patent Owner states that “[a]t paragraph 17, Mr. Hampton affirmatively states that the tracers are admixed with the fracturing materials. At paragraph 18, Mr. Hampton affirmatively states that flowback samples are analyzed for the concentration of the tracer present in the production fluid. Please note that as further proof of this issue, a flowback report is being filed herewith and is discussed at paragraph 19. Mr. Hampton affirmatively states that a calculation is performed with each job and this is discussed at paragraph 20.

However, the additional evidence submitted with the Supplemental Declaration of Mr. Hampton is still insufficient to show a nexus between the claimed invention and the commercial service.

At paragraphs 17-19 of the Supplemental Declaration, Mr. Hampton states that ProTechnics performs the admixing step at the oil well. ProTechnics injects the tracer

into the flow of the hydraulic fracture fluid as it is being pumped down the well at a predetermined rate. The flowback samples are analyzed for the concentration of the tracer present in the production fluid. However, the flowback report referred by Mr. Hampton as evidence does not show that the amount of the admixture recovered is <u>calculated</u> using the concentration of the tracer present in the production fluid as a basis as recited in the claims of the ‘175 patent.

At paragraph 20 of the Supplemental Declaration, Mr. Hampton states:

> The SpectraChem™ brochure states that "SPECTRACHEM tracers are routinely used to quantify and profile frac fluid clean-up and flowback efficiency over time." See Exhibit B. During the preliminary injunction hearing, I explained that ProTechnics performs this step by either using a mass balance approach or a relative rate of recovery approach. See Exhibit A, page 28, line 1, to page 32, line 5. Using the example flowback report, I explained that the graph on page 4 of the report showed the concentration of each tracer over time. See id.; see also Exhibit C. I explained that for stages one and two of this well, the tracer concentration was zero, indicating that there was no flowback from these two stages of the well. This information allowed the well operator to determine that there was an obstruction in the wellbore, and helped to pinpoint the location of the obstruction. See id., page 28, lines 14-25. I also explained that the tracer concentrations were used to determine the amounts of fluid that were flowing back. See id., page 29, line 1, to page 32, line 6.

Mr. Hampton relies on the commercial brochure and the flowback report as evidence to show that the calculation step in the commercial service is performed. However, both the commercial brochure and the flowback report do not show that the amount of the admixture recovered is <u>calculated</u> using the concentration of the tracer present in the production fluid as a basis.

B. Patent Owner also cites a declaration of Mr. Mike Flecker and the Supplemental Declaration of Mr. Hampton and argues the following (pages 38-39 of the response filed on 9/16/2013):

> Mr. Flecker testifies that since its introduction, the invention has captured 100% of the market except during periods of patent infringement. Also included in Mr. Flecker's declaration is a graph showing the rate of growth of revenues from the sale of the SpectraChem Services as a function of time. It is important to note that even with the downturn in the economy and price erosion caused by the Requester, the Patent Owner's revenues associated with the sales of the patented services have continued to climb at a dramatic rate.
>
> Turning to the Examiner's complaint that the Patent Owner has not shown that any commercial success of the SpectraChem is not the result of other factors such as the result of heavy promotion/advertising or consumption by purchasers normally tied to the Patent Owner; the Patent Owner provides evidence in the form of Mr. Hampton's supplemental declaration stating that the Patent Owner's marketing costs are less than 0.1% of revenues. Also disclosed therein is an affirmative assertion by the Patent Owner that the purchasers of the SpectraChem services are oil and gas production and exploration companies that are not related to or affiliated with the Patent Owner.

Patent Owner’s arguments are not persuasive for the same reasons as stated on pages 39-41 of the ACP filed 8/16/2013. Specifically, an affidavit or declaration attributing commercial success to a product or process "constructed according to the disclosure and claims of [the] patent application" or other equivalent language does not establish a nexus between the claimed invention and the commercial success because there is no evidence that the product or process which has been sold corresponds to the claimed invention, or that whatever commercial success may have occurred is attributable to the product or process defined by the claims. *Ex parte Standish*, 10 USPQ2d 1454, 1458 (Bd. Pat. App. & Inter. 1988). Also, MPEP 716.03(a).

Further, as also argued by Requester (pages 31-32 of the comments filed on 10/7/2013):

> In Requester's Comments filed on February 20, 2013, Requester showed that the Patent Owner's alleged sales over an 11 1/2 year period from July 2001 were neither surprising, unusual, nor out of the ordinary in comparison to the size of the Patent Owner's business and the market share which it enjoys. The Patent Owner is one of the world's leading providers of reservoir services to the oil and gas industry, with 70 offices in more than 50 countries and approximately 5000 employees. The Patent Owner's total revenues for the period extending from 2001 through 2012 were over $6,416 million. Consequently, a total sales number of $100 million for the patented method for the years 2001-2012 would amount to only 1.56% of the Patent Owner's total revenues over the same period.
>
> Moreover, even if "commercial success" had been shown by the Patent Owner, "[m]erely showing that there was commercial success of an article which embodied the invention is not sufficient." MPEP § 716.03 (b) (I). "To be pertinent to the issue of nonobviousness, the commercial success of devices falling within the claims of the patent must flow from the functions and advantages disclosed or inherent in the description in the specification." MPEP §716.03 (b) (II). "[C]onclusory statements or opinions that increased sales were due to the merits of the invention are entitled to little weight." Id.

Requester also notes the following (page 33 of the comments filed on 10/7/2013):

> Although the Patent Owner, not the Requester STS, bears the burden of proof on the Patent Owner's claim of commercial success, Requester presented significant evidence in its earlier Comments filed on February 20, 2013 that:
>
> - Concerning its revenues over the years in question, the Patent Owner's Annual Report for 2011 credits typical market forces in the oil and gas industry.
>
> - Not only have the sales of the Patent Owner's ProTechnics division simply tracked the obvious market factors identified in the annual reports, but ProTechnics' sales of these types of services, though they have generally increased in correspondence with these obvious market factors over the period in question, have actually lagged behind the increase in the use of fracturing operations and the related completion of horizontal wells industry-wide.

- While ProTechnics' sales increased from $25 million in 2003 to $118 million in 2012, fracturing activity, as indicated by frac horsepower, increased from 2.063 million horsepower in 2003 to 17.991 million horsepower in 2012 and the number of horizontal well completions increased from 1,400 in 2003 to 17,700 in 2012. Thus, while the level of fracturing activity in 2012 was 8.7 times the level of activity in 2003 and the number of horizontal completions in 2012 was 12.6 times the number in 2003, ProTechnics sales in 2012 were only 4.7 times its sales in 2003.

- Consequently, contrary to its claim of commercial success, ProTechnics' sales have not actually even kept pace with fracturing activities and expenditures in the industry overall.

- ProTechnics' sales from 2003 to the present predictably followed the obvious market factors such as the price of oil, fracturing activity, and the number of horizontal well completions.

C. Patent Owner also cites the Supplemental Declaration of Hampton and argues the following (pages 39-40 of the response filed on 9/16/2013):

> [t]he Examiner's attention is directed to Mr. Hampton's supplemental declaration at paragraph 22. Therein it is disclosed that the "solution" provided by the SPE 31094 reference does not indeed solve the long felt need disclosed therein. For example it does not provide any way to differentiate one fracture zone or stage from another.

Patent Owner's arguments are not commensurate with the scope of the claims. The claims of the ‘175 patent do not require any method step “to differentiate one fracture zone or stage from another.” The ‘175 patent also does not describe that there is a long felt need of providing a way “to differentiate one fracture zone or stage from another.”

Further, as also argued by Requester (page 28 of the comments filed on 10/7/2013):

> SPE 31094 does not even mention fracture zones or stages and never states that a need exists for a way to differentiate one fracture zone for another. Consequently, SPE 31094 provides absolutely no objective evidence of the existence of the new "need" which the Patent Owner wishes to create.

D. With respect to the secondary consideration of praise by other and copying by others (pages 40-42 of the response filed on 9/16/2013), Patent Owner maintains the same arguments as presented in the response filed on 1/22/2013. Patent Owner's arguments are not persuasive for the same reasons as set forth at pages 38-39 of the ACP filed on 8/16/2013.

E. Patent Owner also cites *In re Leo Pharmaceutical Products, Ltd.*, 2013 U.S. App. Lexis 16610 and argued that the evidence of commercial success of the invention as claimed is clear and convincing (pages 38-39 of the response filed on 9/16/2013) and that “[t]he Examiner's argument that the claims as amended are obvious is far from strong. This is shown by the number of references to which the Examiner was forced to resort; and the age of many of the Examiner's references. Hinkel issued in 2001 but was filed in 1998. Dugstad was published in 1999. Hall was filed in 1988. Hoots was filed in 1987. And the other references are all older, some going back as far as 1962” (pages 42-43 of the response filed on 9/16/2013).

Patent Owner’s arguments are not persuasive. As argued by Requester (pages 24-26 of the comments filed on 10/7/2013):

> The patent claims in Leo Pharmaceutical were for a topical skin treatment composition for psoriasis which was "storage stable." The objective "secondary" indicia of non-obvious presented by Leo consisted, first of all, of a very strong and thorough showing of unexpected results based not only upon several articles

> which discouraged the combination of components called for in the claims, but also upon "extensive experimental evidence."
>
> Through its experimental tests, which required months to perform, Leo was able to determine and prove that none of the closest prior art compositions were storage stable. Moreover, although the prior art compositions had been known for decades, there was no evidence that, prior to Leo's findings, which took months to discover, the industry had even been aware that the prior art compositions were not storage stable. Consequently, concerning the combination of prior art references which had been cited against the patent claims, there was actually no reason or incentive known to those in the art to apply the teachings of the secondary references to the prior art compositions.
>
> The strong showing of unexpected results was also further supported and confirmed by significant related evidence of commercial success and evidence of long felt but unresolved need. As evidence of commercial success supporting the finding of unexpected results, Leo's product covered by the patent claims became the first FDA-approved drug to combine vitamin D and corticosteroids into a single formula for topical application. As stated by the Court:
>
> > While FDA approval is not determinative of nonobviousness, it can be relevant in evaluating the objective indicia of nonobviousness. *** Here, FDA approval highlights that Leo Pharmaceutical's formulation is truly storage stable, something that the prior art formulations did not achieve. Leo Pharmaceutical at 33 (citations omitted).
>
> As further confirmation of the unexpected result obtained by Leo, the record also showed that researchers were aware of the benefits of using vitamin D and corticosteroids in the treatment of psoriasis as early as 1986. However, it was not until 2000 that Leo's combined treatment was created.
>
> The convincing proof of unexpected results presented by Leo supported by FDA approval of the composition satisfying a long felt need is in stark contrast to Patent Owner's failure to prove any objective "secondary" indicia of non-obvious.

With respect to the argument relating to the number of references cited, “reliance on a large number of references in a rejection does not, without more, weigh against the obviousness of the claimed invention.” See *In re Gorman*, 933 F.2d 982, 18 USPQ2d 1885 (Fed. Cir. 1991).

In response to Patent Owner's argument based upon the age of the references, "contentions that the reference patents are old are not impressive absent a showing that the art tried and failed to solve the same problem notwithstanding its presumed knowledge of the references." See *In re Wright*, 569 F.2d 1124, 193 USPQ 332 (CCPA 1977).

Conclusion

The patent owner is reminded of the continuing responsibility under 37 CFR 1.565(a) to apprise the Office of any litigation activity, or other prior or concurrent proceeding, involving Patent No. 6,659,175 throughout the course of this reexamination proceeding. The third party Requester is also reminded of the ability to similarly apprise the Office of any such activity or proceeding throughout the course of this reexamination proceeding.

This is a RIGHT OF APPEAL NOTICE (RAN); see MPEP § 2673.02 and § 2674. The decision in this Office action as to the patentability or unpatentability of any original patent claim, any proposed amended claim and any new claim in this proceeding is a FINAL DECISION.

No amendment can be made in response to the Right of Appeal Notice in an inter partes reexamination. 37 CFR 1.953(c). Further, no affidavit or other evidence can be submitted in an inter partes reexamination proceeding after the right of appeal notice, except as provided in 37 CFR 1.981 or as permitted by 37 CFR41.77(b)(1). 37 CFR 1.116(f).

Each party has **a thirty-day or one-month time period, whichever is longer**, to file a notice of appeal. The patent owner may appeal to the Patent Trial and Appeal Board with respect to any decision adverse to the patentability of any original or proposed amended or new claim of the patent by filing a notice of appeal and paying the fee set forth in 37 CFR 41.20(b)(1). The third party requester may appeal to the Patent Trial and Appeal Board with respect to any decision favorable to the patentability of any original or proposed amended or new claim of the patent by filing a notice of appeal and paying the fee set forth in 37 CFR 41.20(b)(1).

In addition, a patent owner who has not filed a notice of appeal may file a notice of cross appeal within **fourteen days of service** of a third party requester's timely filed notice of appeal and pay the fee set forth in 37 CFR 41.20(b)(1). A third party requester who has not filed a notice of appeal may file **a notice of cross appeal within fourteen days of service** of a patent owner's timely filed notice of appeal and pay the fee set forth in 37 CFR 41.20(b)(1).

Any appeal in this proceeding must identify the claim(s) appealed, and must be signed by the patent owner (for a patent owner appeal) or the third party requester (for a third party requester appeal), or their duly authorized attorney or agent.

Any party that does not file a timely notice of appeal or a timely notice of cross appeal will lose the right to appeal from any decision adverse to that party, but will not lose the right to file a respondent brief and fee where it is appropriate for that party to do so. If no party files a timely appeal, the reexamination prosecution will be terminated,

and the Director will proceed to issue and publish a certificate under 37 CFR 1.997 in accordance with this Office action.

All correspondence relating to this *inter partes* reexamination proceeding should be directed:

By EFS: Registered users may submit via the electronic filing system EFS-Web at
https://efs.uspto.gov/efile/myportal/efs-registered

Please mail any communications to:
Attn: Mail Stop "Inter Partes Reexam"
Central Reexamination Unit
Commissioner for Patents
P. O. Box 1450
Alexandria VA 22313-1450

Please hand-deliver any communications to:
Customer Service Window
Attn: Central Reexamination Unit
Randolph Building, Lobby Level
401 Dulany Street
Alexandria, VA 22314

Please FAX any communications to:
(571) 273-9900
Central Reexamination Unit

Signed:

/Ling Xu/
Patent Reexamination Specialist
Central Reexamination Unit 3991

Conferees:

/Alan Diamond/
Patent Reexamination Specialist
Central Reexamination Unit 3991

/Deborah D Jones/
Supervisory Patent Examiner, Art Unit 3991

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
95/002,144	09/06/2012	7,032,662 B2	COR-1026-USCP-RE	4954

87627 7590 02/07/2014
Mossman, Kumar & Tyler PC
P.O. Box 421239
Houston, TX 77242

EXAMINER	
XU, LING X	

ART UNIT	PAPER NUMBER
3991	

MAIL DATE	DELIVERY MODE
02/07/2014	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Transmittal of Communication to Third Party Requester *Inter Partes* Reexamination	Control No. 95/002,144	Patent Under Reexamination 7,032,662	
	Examiner Ling Xu	Art Unit 3991	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address. --

(THIRD PARTY REQUESTER'S CORRESPONDENCE ADDRESS)

BROWN PATENT LAW, P.L.L.C.
2700 N. HEMLOCK CT. SUITE 111E
BROKEN ARROW, OK 74012

Enclosed is a copy of the latest communication from the United States Patent and Trademark Office in the above-identified reexamination prceeding. 37 CFR 1.903.

Prior to the filing of a Notice of Appeal, each time the patent owner responds to this communication, the third party requester of the *inter partes* reexamination may once file written comments within a period of 30 days from the date of service of the patent owner's response. This 30-day time period is statutory (35 U.S.C. 314(b)(2)), and, as such, it cannot be extended. See also 37 CFR 1.947.

If an *ex parte* reexamination has been merged with the *inter partes* reexamination, no responsive submission by any *ex parte* third party requester is permitted.

All correspondence relating to this inter partes reexamination proceeding should be directed to the **Central Reexamination Unit** at the mail, FAX, or hand-carry addresses given at the end of the communication enclosed with this transmittal.

Right of Appeal Notice (37 CFR 1.953)	Control No. 95/002,144	Patent Under Reexamination 7,032,662
	Examiner Ling Xu	Art Unit 3991

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address. --

Responsive to the communication(s) filed by:
Patent Owner on 16 September, 2013
Third Party(ies) on 07 October, 2013

Patent owner and/or third party requester(s) may file a notice of appeal with respect to any adverse decision with payment of the fee set forth in 37 CFR 41.20(b)(1) within **one-month or thirty-days (whichever is longer)**. See MPEP 2671. In addition, a party may file a notice of **cross** appeal and pay the 37 CFR 41.20(b)(1) fee **within fourteen days of service** of an opposing party's timely filed notice of appeal. See MPEP 2672.

All correspondence relating to this inter partes reexamination proceeding should be directed to the **Central Reexamination Unit** at the mail, FAX, or hand-carry addresses given at the end of this Office action.

If no party timely files a notice of appeal, prosecution on the merits of this reexamination proceeding will be concluded, and the Director of the USPTO will proceed to issue and publish a certificate under 37 CFR 1.997 in accordance with this Office action.

The proposed amendment filed _____ ☐ will be entered ☐ will not be entered*

*Reasons for non-entry are given in the body of this notice.

1a. ☒ Claims 1-7,9,10 and 13-21 are subject to reexamination.
1b. ☒ Claims 11 and 12 are not subject to reexamination.
2. ☒ Claims 8 have been cancelled.
3. ☐ Claims _____ are confirmed. [Unamended patent claims].
4. ☐ Claims _____ are patentable. [Amended or new claims].
5. ☒ Claims 1-7, 9-10 and 13-21 are rejected.
6. ☐ Claims _____ are objected to.
7. ☐ The drawings filed on _____ ☐ are acceptable. ☐ are not acceptable.
8. ☐ The drawing correction request filed on _____ is ☐ approved. ☐ disapproved.
9. ☐ Acknowledgment is made of the claim for priority under 35 U.S.C. 119 (a)-(d) or (f). The certified copy has:
   ☐ been received. ☐ not been received. ☐ been filed in Application/Control No. _____.
10. ☐ Other _____

Attachments
1. ☐ Notice of References Cited by Examiner, PTO-892
2. ☐ Information Disclosure Citation, PTO/SB/08
3. ☐ _____

Detailed Action

Status of Proceedings

September 6, 2012:	A request for *inter partes* reexamination of claims 1-10 and 13-21 of United States Patent Number 7,032,662 (hereinafter “the ‘662 patent”) was filed by a Third Party Requester.
November 19, 2012:	An Order granting the request for *inter partes* reexamination of claims 1-10 and 13-21 of the '662 patent was mailed. A non-final Office action on the merits was also mailed on the same date.
January 22, 2013:	Patent Owner filed a response to the non-final Office action dated November 19, 2012 including an amendment canceling claim 8.
February 20, 2013:	Requester filed comments to Patent Owner's response filed January 22, 2013.
August 16, 2013:	An Action Closing Prosecution (ACP) was mailed.
September 16, 2013:	Patent Owner filed a response to the ACP mailed August 16, 2013.
October 7, 2013:	Requester filed comments to Patent Owner's response filed September 16, 2013.

References Cited

- Deans et al., U.S. Patent No. 4,090,398, hereinafter "Deans";
- Hall, European Patent Application Publication No. 0 282 032, hereinafter "Hall";
- SPE 56427, Dugstad, et al., *Application of Tracers to Monitor Fluid Flow in the Snorre Field: A Field Study*, Society of Petroleum Engineers Inc., 1999, hereinafter "Dugstad";
- Hinkel et al., U.S. Patent No. 6,192,985, hereinafter "Hinkel";
- Teasdale et al., U.S. Patent No. 4,223,725, hereinafter "Teasdale";
- Greenkorn, *Experimental Study of Waterflood Tracers*, Journal of Petroleum Technology, January 1962, pages 87-92, hereinafter "Greenkorn";
- Bowman, *Evaluation of Some New Tracers for Soil Water Studies*, Soil Science Soc. Am. J., Vol. 48, 1984, pages 987-993, hereinafter "Bowman";
- Hoots et al., U.S. Patent No. 4,783,314, hereinafter "Hoots";
- Chen et al., U.S. Patent No. 4,303,411, hereinafter "Chen".

Scope of claims

In reexamination, patent claims are construed broadly. *In re Yamamoto*, 740 F.2d 1569, 1571, 222 USPQ 934, 936 (Fed. Cir.1984) (claims given "their broadest reasonable interpretation consistent with the specification"). Amended claims 1-7, 9-10 and 13-21 of the '662 patent are directed to a method for determining the extent of recovery of materials injected into an oil well. Independent claims 1 and 14 are representative:

1. A method for determining the extent of recovery of materials injected into an oil well comprising: a) admixing a material to be injected into an oil well with a chemical tracer compound at a predetermined concentration; <u>wherein the material to be injected into the oil well is a hydraulic fracturing fluid</u>; b) injecting the admixture into an oil well or an offset well associated with an oil well; c) recovering from the oil well a production fluid; d) analyzing the production fluid for a concentration of the chemical tracer present in the production fluid; and e) calculating the amount of admixture recovered from the oil well using the concentration of the chemical tracer present in the production fluid as a basis for the calculation.

14. A method for determining the extent of recovery of a material of interest injected into an oil well or a subsurface formation associated with a bore of the oil well comprising: a) introducing a material of interest into the oil well or into the subsurface formation associated with the bore of the oil well; <u>wherein the material of interest injected into the oil well is a material useful for hydraulically fracturing the oil well;</u> b) introducing a tracer into the oil well or into the subsurface formation associated with the bore of the oil well; c) recovering from the oil well a production fluid; d) analyzing the production fluid for a concentration of the chemical tracer present in the production fluid; and e) calculating the amount of material of interest recovered from the oil well using the concentration of the chemical tracer present in the production fluid as a basis for the calculation.

Claim Interpretation

Claim 1 recites a method for determining the extent of recovery of materials injected into an oil well. The claim does not limit the claimed method to be a hydraulically fracturing process. Patent Owner amended claim 1 by incorporating the claim limitation of claim 8 into claim 1. The added limitation recites that "the material injected into the oil well is a hydraulically fracturing fluid." However, the added limitation does not change the claimed method to be a hydraulically fracturing method. It only

recites that the injected material is a hydraulically fracturing fluid (e.g., aqueous-based solutions).

Similarly, claim 14 recites a method for determining the extent of recovery of a material of interest injected into an oil well or a subsurface formation associated with a bore of the oil well. The claim does not limit the claimed method to be a hydraulically fracturing method. Patent Owner amended claim 14 by adding the limitation that “the material of interest injected into the oil well is a material useful for hydraulically fracturing the oil well.” However, the added limitation does not further limit the scope of the claimed method to a hydraulically fracturing method.

Accordingly, for the reasons stated above, claims 1 and 14 as amended do not require that the claimed method is a hydraulically fracturing process.

Claim Rejections - 35 USC § 103

The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Requester's Proposed Rejections

I. Claims 1, 5-6, 9, 14, 17 and 19 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Hinkel in view of Deans.

The rejection of claims 1, 5-6, 9, 14, 17 and 19 was proposed by Requester on pages 4-8 and 35-37 of the comments filed on 2/20/2013. The proposed rejection is **adopted** for the following reasons.

Hinkel discloses a hydraulic fracturing method used to stimulate the production of fluids resident in the subsurface, e.g., oil, natural gas, and brines. Hinkel describes that the fracturing method involves breaking or fracturing a portion of the surrounding strata by injecting a specialized fluid into the wellbore directed at the face of the geologic formation (col. 1, lines 45-55). Hinkel also discloses a fracture clean-up process which involves recovering the injected fluid from the fracture (col. 3, lines 9-19 and also Examples). Hinkel further discloses that tracers can be added to the various fracturing fluid stages in actual field applications so that a tracer study can be performed to verify the effectiveness of the fracture clean-up process (see Example 4).

Hinkel does not specify that the amount of fracturing fluid recovered can be determined/calculated based upon the concentration of the tracer in the produced/recovered fluid.

Deans teaches the use of tracer concentration profiles in the produced fluid for material balance purposes to determine/calculate the amount of injected fluid recovered. Deans describes that (col. 3, lines 10-20):

> "[t]he injected fluid preferably contains a tracer to aid in analyzing the flow behavior of the injected fluid within the formation. As the injected fluid flows radially away from the wellbore it dissolves immobile fluid and reduces the immobile fluid saturation. Preferably the flow is reversed and the injected fluid is produced through the injection well in an amount sufficient to determine the volume of injected fluid substantially unsaturated with immobile fluid."

Deans also discloses that the tracer is used only for material balance purposes. The concentration of the trace chemical in the injected fluid can be established by one of ordinary skill in the art using general engineering principles (col. 7, lines 16-20 and 30-32).

Deans further discloses that (col. 6, lines 16-18):

> "[t]he principal purpose for using a tracer is to aid in determining the fluid flow characteristics such as fluid drift and dispersion of the injected fluid. Any suitable tracer can be added to the injected fluid and the return profiles considered in calculating the residual fluid saturation. <u>The chemical tracer is preferably detected and its concentration measured</u> <u>when the produced fluid is analyzed for the dissolved immobile fluid concentration.</u> <u>The tracer concentration profile may be used for determining when the total volume of fluid injected into the formation has been produced.</u> Thus, knowledge of when the volume of injected fluid has been produced can be determined either by knowing the total injected fluid volume or by measuring the tracer concentration profile in the produced fluid and determining the injected fluid volume using general engineering principles." (Emphasis added)

Accordingly, Deans discloses that the concentration of the tracer in the produced fluid can be measured and used for material balance purpose to determine the fluid flow characteristics including using the tracer concentration profile as a basis to determine the amount of the injected fluid produced (recovered).

Deans also discloses that the injected fluid can be an aqueous fluid such as brine (col. 4, lines 11-15 and claims 2-3). Aqueous fluids are well-known materials useful for hydraulically fracturing an oil well.

Accordingly, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the tracer concentration profiles in the produced/recovered fluid to calculate the amount of injected fluid recovered, as

suggested by Deans, in order to determine the effectiveness of the fracture clean-up process disclosed in Hinkel.

With respect to claims 5-6, Deans discloses that the concentration of the tracer in the injected fluid is ranged from about one-half to two percent by volume (5000 - 20,000ppm) (col. 7, lines 33-35), which is within the ranges as recited in claims 5-6.

II. Claims 2-4, 10 and 15-21 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Hinkel and Deans and further in view of Dugstad.

The above rejection was proposed by Requester on pages 4-8 and 35-37 of the comments filed on 2/20/2013. The proposed rejection **is adopted** for the following reasons.

The combination of Hinkel and Deans is relied upon for the reasons stated in I above.

Deans also discloses that the trace chemicals can be selected from a wide category of known and available substances, preferably, the trace chemicals should be soluble in the injected fluid and it should have little or no tendency to adsorb on or react with the matrix of the porous medium (col. 7, lines 10-21).

Deans further discloses that the injected fluid can be produced from the formation by means of a second well (col.3, lines 20-22).

With respect to claims 2-4 and 15-20, the combination of Hinkel and Deans does not disclose the use of the specific tracers as claimed. However, the tracers as recited

in these claims are well known in the art. For example, Dugstad teaches the use of fluorinated benzoic acids (e.g. 4-fluorobenzoic acid) as water tracers in a tracer program to improve the understanding of the flow dynamics and WAG (water-alternating-gas) injection efficiency in the reservoir (page 1, 1st column).

With respect to claims 10 and 21, Deans does not disclose the use of the specific formula as claimed for determining the amount of injected admixture recovered.

Dugstad teaches the use of the following formula to determine the tracer recovery ratio based on the tracer concentration profile (page 2):

$$R_c = \frac{\sum_{i=1}^{n} C_i V_i}{M}$$

wherein *Ci* is the concentration of tracer in sample i, *Vi* is the volume of water produced between samples i and i+ 1, *M* is the amount of tracer injected, and n is the number of samples collected.

For each sample period or when only a single sample is taken (n=1), the above formula can be simplified as (see the request, pages 18-20):

$$\mathrm{Rc} = \frac{\mathrm{CV}}{\mathrm{M}} \text{ or } \mathrm{Rc} = \frac{\text{Tracer Rcovered}}{\text{Tracer Injected}}$$

It is noted that the specification of the ‘662 patent indicates that the extent of recovery of materials injected including a tracer is determined by using a mass balance approach (see the ‘662 patent, col. 5, line 62 - col. 6, line 10). The amount of tracer recovered can be determined using the following formula, which is also recited in claims 10 and 21.

$$Admixture\ Recovered = \left(\frac{Tracer\ Recovered}{Tracer\ Injected}\right)*(Admixture\ Injected)$$

The above formula can be rearranged as follow:

$$\frac{Admixture\ Recovered}{Admixture\ Injected} = \frac{Tracer\ Recovered}{Tracer\ Injected}$$

In other words, the ratio or percentage amount of the total Admixture Recovered is equal to the ratio or percentage amount of the Tracer Recovered (see the request, pages 4-7).

As stated above, Dugstad teaches the use of the following formula to determine the tracer recovery ratio based on the tracer concentration profile:

$$\mathrm{Rc} = \frac{\text{Tracer Rcovered}}{\text{Tracer Injected}}$$

Accordingly, Dugstad teaches the use of the same mass balance approach as described in the ‘662 patent and in claims 10 and 21 to calculate the ratio of the amount injected fluid recovered based on the tracer concentration profile.

Therefore, it would have been obvious to one of ordinary skill in the art, searching for a suitable trace chemical to aid in determining the fluid flow characteristics in Hinkel and Deans, to select the fluorinated benzoic acid as the tracer since fluorinated benzoic acids are known to be used as a water tracer and have a higher recovery rate than other water tracers (Dugstad, page 2). In order to determine the recovery rate, one skilled in the art would have also used the formula provided by Dugstad to calculate/determine the ratio or the amount injected fluid recovered based on the tracer concentration profile.

III. Claims 5-7 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Hinkel and Deans and further in view of Chen.

The above rejection was proposed by Requester on pages 4-8 and 35-37 of the comments filed on 2/20/2013. The proposed rejection **is adopted** for the following reasons.

The combination of Hinkel and Deans is relied upon for the reasons stated in I above.

Deans also discloses that the concentration of the trace chemical in the injected fluid can be established by one of ordinary skill in the art using general engineering principles. As a matter of economics, the concentration of the tracer in the injected fluid can range from about one-half to two percent by volume (5000 - 20,000ppm) (col. 7, lines 33-35).

The combination of Hinkel and Deans does not specify that the concentration range of tracer is from about 100 parts per trillion to about 100 parts per million.

Chen teaches a method for determining flow patterns within a subterranean formation penetrated by an injection system and production system. The method comprises injecting into the formation a saline solution containing a small amount of one or more water-soluble tracer compounds, recovering the saline solution in the production system, determining the depth of recovery, and identifying the tracer compounds by FNMR spectroscopy (col. 1, lines 39-50).

Chen also teaches that the tracer compounds are water-soluble alkali metal salts of inorganic or organic compounds having fluorine in the anion (col. 1, lines 39-50). The amount of the tracer used in the injected solution is small and, preferably, is between about 300 to about 2000ppm (col. 2, lines 39-40). Examples of Chen show that the amount of tracer in the injected solution can be as low as 3 ppm, which is within the range as claimed.

Accordingly, it would have been obvious to one of ordinary skill in the art to use sufficiently small amount of the tracer compounds, as suggested by Chen, in the injected fluids disclosed in Hinkel and Deans in order to lower the operation cost and also reduce the negative effects that the tracers cause to the environment.

IV. Claims 5-7 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Hinkel and Deans and further in view of Hoots.

The above rejection was proposed by Requester on pages 4-8 and 35-37 of the comments filed on 2/20/2013. The proposed rejection **is adopted** for the following reasons.

The combination of Hinkel and Deans is relied upon for the reasons stated in I above.

Deans also discloses that the injected fluid can be an aqueous fluid, brine, or a hydrocarbon (see claims 2-4). The concentration of the trace chemical in the injected fluid can be established by one of ordinary skill in the art using general engineering

principles. As a matter of economics, the concentration of the tracer in the injected fluid can range from about one-half to two percent by volume (5000 - 20,000ppm) (col. 7, lines 33-35).

The combination of Hinkel and Deans does not specify that the concentration range of tracer is from about 100 parts per trillion to about 100 parts per million.

Hoots teaches a method of using fluorescent tracers in a liquid system to which a treating chemical is added. The method can be utilized in a broad range of aqueous, mixed aqueous/non-aqueous, or non-aqueous liquid systems (e.g. down-hole oil field applications) (col. 3, lines 9-13). The fluorescent tracers are used to quantify and control feed rate(s) of treating chemicals into the liquid system. In addition, the fluorescent tracers can also be used to quantify important characteristics of the liquid system such as total volume and amount of a liquid entering and leaving the system (col. 1, lines 6-16).

Hoots also teaches (col. 12, lines 61-64) that "[b]y properly choosing the fluorescing reagent, quantitative and in-situ measurement of tracer levels from parts per trillion (ppt) to parts per million (ppm) can be routinely accomplished on an instant or continuous basis with inexpensive portable equipment."

Accordingly, it would have been obvious to one of ordinary skill in the art to use sufficiently small amount of the tracer chemicals, as suggested by Hoots, in the injected fluids disclosed in Hinkel and Deans in order to lower the operation cost and also reduce the negative effects that the tracers cause to the environment.

V. Claims 5-6 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Hinkel and Deans and further in view of Teasdale.

The above rejection was proposed by Requester on pages 4-8 and 35-37 of the comments filed on 2/20/2013. The proposed rejection **is adopted** for the following reasons.

The combination of Hinkel and Deans is relied upon for the reasons stated in I above.

Deans also discloses that the concentration of the trace chemical in the injected fluid can be established by one of ordinary skill in the art using general engineering principles. As a matter of economics, the concentration of the tracer in the injected fluid can range from about one-half to two percent by volume (5000 - 20,000ppm) (col. 7, lines 33-35).

Teasdale teaches (col. 1, lines 48-59):

> "a method for determining the magnitude of the fluid drift rate within a reservoir. The method comprises the steps of first injecting a known volume of a tracer-containing fluid into the reservoir, then waiting for a period of time sufficient to allow movement of the injected tracer containing fluid under the influence of the reservoir fluid drift rate, then producing fluids from said well while systematically analyzing produced fluid samples to determine the produced fluid tracer concentration, and finally calculating therefrom the magnitude of the fluid drift rate in the reservoir."

Teasdale also teaches the use of well-known tracers such as sodium bromide, potassium iodide and lithium chloride (col. 1, lines 66-col. 2, lines 10) at a concentration of 1,000 ppm (col. 1, lines 66-col. 2, line 10), which is within the range as recited in claims 5-6.

Accordingly, it would have been obvious to one of ordinary skill in the art to use sufficiently smaller amount of the tracer chemicals, as suggested by Teasdale, in the injected fluids disclosed in Hinkel and Deans in order to lower the cost and also reduce the negative effects that the tracers cause to the environment.

VI. Claims 5-7 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Hinkel and Deans and further in view of Greenkorn.

The above rejection was proposed by Requester on pages 4-8 and 35-37 of the comments filed on 2/20/2013. The proposed rejection **is adopted** for the following reasons.

The combination of Hinkel and Deans is relied upon for the reasons stated in I above.

Deans also discloses that the concentration of the trace chemical in the injected fluid can be established by one of ordinary skill in the art using general engineering principles. As a matter of economics, the concentration of the tracer in the injected fluid can range from about one-half to two percent by volume (5000 - 20,000ppm) (col. 7, lines 33-35).

The combination of Hinkel and Deans does not specify that the concentration range of tracer is from about 100 parts per trillion to about 100 parts per million.

Greenkorn teaches the use of tracers in injected fluids to determine the flow paths of waterflood or subsurface liquids. Examples of the water tracers include tritiated

water, bromine, chloride, and iodide (page 89). The experimental study performed by Greenkorn indicates that these tracers give similar breakthrough-elution curves and material balances within practical accuracy, and the analysis of these tracers are relatively simple (page 89). Greenkorn also teaches that the amount of the tracer in the injected fluids can be as low as 71.4 ppm and 79 ppm, which are within the ranges as recited in claims 5-7.

Accordingly, it would have been obvious to one of ordinary skill in the art to use sufficiently small amount of the tracer compounds, as suggested by Greenkorn, in the injected fluids disclosed in Hinkel and Deans in order to lower the operation cost and also reduce the negative effects that the tracers cause to the environment.

VII. Claims 2-4 and 15-20 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Hinkel and Deans and further in view of Teasdale and Bowman.

The rejection of claims 2-4 and 15-21 was proposed by Requester on pages 4-8 and 35-37 of the comments filed on 2/20/2013. The proposed rejection of claims 2-4 and 15-20 **is adopted** for the following reasons. The proposed rejection of claim 21 (see page 36 of the comments filed on 2/20/2013) is **not adopted** because the combination of the cited references does not teach the claimed limitation.

The combination of Hinkel and Deans is relied upon for the reasons stated in I above.

Deans also discloses that the trace chemicals can be selected from a wide category of known and available substances, preferably, the trace chemicals should be soluble in the injected fluid and it should have little or no tendency to adsorb on or react with the matrix of the porous medium (col. 7, lines 10-21).

Deans further discloses that the injected fluid can be produced from the formation by means of a second well (col.3, lines 20-22).

The combination of Hinkel and Deans does not disclose the use of the specific tracers as recited in claims 2-4 and 15-20.

Teasdale teaches (col. 1, lines 48-59):

> "a method for determining the magnitude of the fluid drift rate within a reservoir. The method comprises the steps of first injecting a known volume of a tracer-containing fluid into the reservoir, then waiting for a period of time sufficient to allow movement of the injected tracer containing fluid under the influence of the reservoir fluid drift rate, then producing fluids from said well while systematically analyzing produced fluid samples to determine the produced fluid tracer concentration, and finally calculating therefrom the magnitude of the fluid drift rate in the reservoir."

Teasdale also teaches the use of well-known tracers such as sodium bromide, potassium iodide, lithium chloride (col. 1, lines 66-col. 2, lines 10).

Bowman discloses the use of water tracers including deuterated and tritiated water, bromine, chloride, and iodide in soil water. Of these common water tracers, Bowman describes that bromide is the most generally suitable tracer for soil water (page 987). In addition, a study performed by Bowman also indicates that the following tracers exhibit characteristics most similar to bromide: (i) o-(trifluoromethyl)benzoic acid (o-TFMBA), (ii) penta fluoro benzoic acid (PFBA), and (iii) 2,6- difluorobenzoic acid (2,6

- DFBA). These tracers are particularly useful in field studies when multiple tracers or totally exotic tracers are desired (page 992).

Accordingly, it would have been obvious to one of ordinary skill in the art, searching for a suitable trace chemical for use in the injected fluids disclosed in Hinkel and Deans, to select the fluorinated benzoic acids as the tracer since these fluorinated benzoic acids exhibit highly desirable performance and characteristics including resistance to chemical and microbial degradation (see Bowman, page 988, 1st column) in natural environments and environments where totally exotic tracers are desired.

VIII. Claims 2-4 and 15-20 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Hinkel and Deans and further in view of Greenkorn and Bowman.

The rejection of claims 2-4 and 15-21 was proposed by Requester on pages 4-8 and 35-37 of the comments filed on 2/20/2013. The proposed rejection of claims 2-4 and 15-20 **is adopted** for the following reasons. The proposed rejection of claim 21 (see page 36 of the comments filed on 2/20/2013) is **not adopted** because the combination of the cited references does not teach the claimed limitation.

The combination of Hinkel and Deans is relied upon for the reasons stated in I above.

Deans also discloses that the trace chemicals can be selected from a wide category of known and available substances, preferably, the trace chemicals should be

soluble in the injected fluid and it should have little or no tendency to adsorb on or react with the matrix of the porous medium (col. 7, lines 10-21).

Deans further discloses that the injected fluid can be produced from the formation by means of a second well (col. 3, lines 20-22).

The combination of Hinkel and Deans does not disclose the use of the specific tracers as recited in claims 2-4 and 15-20. However, the tracers as recited in these claims are well known in the art.

Greenkorn teaches the use of tracers in injected fluids to determine the flow paths of waterflood or subsurface liquids. Examples of the water tracers include tritiated water, bromine, chloride, and iodide (page 89). The experimental study performed by Greenkorn indicates that these tracers give similar breakthrough-elution curves and material balances within practical accuracy, and the analysis of these tracers are relatively simple (page 89).

Bowman discloses the use of water tracers including deuterated and tritiated water, bromine, chloride, and iodide in soil water. Of these common water tracers, Bowman describes that bromide is the most generally suitable tracer for soil water (page 987). In addition, a study performed by Bowman also indicates that the following tracers exhibit characteristics most similar to bromide: (i) o-(trifluoromethyl)benzoic acid (o-TFMBA), (ii) penta fluoro benzoic acid (PFBA), and (iii) 2,6- difluorobenzoic acid (2,6 - DFBA). These tracers are particularly useful in field studies when multiple tracers or totally exotic tracers are desired (page 992).

Accordingly, it would have been obvious to one of ordinary skill in the art, searching for a suitable trace chemical for use in the injected fluids disclosed in Hinkel and Deans, to select the fluorinated benzoic acids as the tracer since these fluorinated benzoic acids exhibit highly desirable performance and characteristics including resistance to chemical and microbial degradation (see Bowman, page 988, 1st column) in natural environments and environments where totally exotic tracers are desired.

IX. Claims 1, 5-6, 9, 13-14, 17 and 19 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Hinkel in view of Hall.

The rejection of claims 1, 5-6, 9, 14, 17 and 19 was proposed by Requester on pages 4-8 and 35-37 of the comments filed on 2/20/2013. The proposed rejection is **adopted** for the following reasons. Claim 13 is included in the above rejection because, as will be discussed in more detail below, Hinkle in view of Hall teaches the claimed limitation.

Hinkel is relied upon for the reasons stated in I above.

Hinkel does not specify that the amount of fracturing fluid recovered can be determined/calculated based upon the concentration of the tracer in the produced/recovered fluid.

Hall teaches a method for monitoring drilling mud circulation in a well wherein a tracer is added to the aqueous drilling mud. Specifically, Hall describes (col. 2, lines 29-41):

> “a method for the monitoring of drilling mud circulation in a wellbore, by injecting in a discrete way a known amount or concentration of at least

> one tracer ion in the supply mud and by analysing on site the return mud for the tracer, said tracer ion being substantially non-interactive with the other mud components and with the strata drilled, the concentration of said tracer ion being measured, as a function of time, in the return mud and its residence time density function f(t) being determined from said measured concentration in order to assess the hydrodynamic dispersion of the circulating mud."

Hall also discloses a preferred operation involves injecting a quantity of tracer into the mud inlet at the surface; detecting quantitatively the time variation of the tracer concentration as it returns to the surface; processing the tracer return concentration data to obtain a residence time distribution for the circulation; using the time distribution to obtain information on the circulation.

Hall further discloses that, if the tracer is inert, any loss of tracer can be interpreted as a loss of fluid in the wellbore (col. 7, lines 6-8). The tracer concentration curve generated from the operation can be used to measure fluid loss during circulation. Specifically, with respect to Figure 8, Hall states that:

> "since the area under the tracer outflow concentration curve eg, area under $C_{out}(t)$ in Fig. 8, is equal to the total amount of tracer material washed out from the well during circulation, a comparison of this quantity with the total amount injected into the well gives, by difference, a measure of fluid loss during circulation (provided the tracer is non-interactive with the mud components and the formation drilled)." (Col. 3, lines 26-35).

Based on the amount of the fluid loss during circulation, the amount of fluid recovered (the amount of fluid not lost) can also be determined/calculated by comparing the amount of the fluid injected into the well and the amount of the fluid loss during circulation. Accordingly, Hall teaches that the amount of the injected fluid recovered from the well can be determined/calculated based on the concentration of the tracer present in the outflow fluid.

Hall also discloses a process of drilling of wellbore into an earth formation using drilling mud/fluid (col. 1, lines 1-30). It is well known in the art that the drilling process disclosed in Hall is most often used for drilling oil and natural gas wells.

Accordingly, it would have been obvious to one of ordinary skill in the art to use the tracer concentration in the produced/recovered fluid to calculate the amount of injected fluid recovered, as suggested by Hall, in order to determine the effectiveness of the fracture clean-up process disclosed in Hinkel.

With respect to claims 5-6, Hall discloses that the concentration of the tracer in the injected fluid is sufficiently small, typically 1% by weight (10,000 ppm) (col. 5, lines 12-15), which is within the ranges as recited in claims 5-6.

With respect to claim 13, Hall discloses that the tracers can be injected into the well as a solid or as a concentrated solution. Specifically, the tracer can be injected in the form of a compact plug of solid or dissolved material (col. 4, lines 25-33). The tracers can also be used in the form of pellets enclosed in a water-proof container (i.e. encapsulated solid) for the purpose of determining the "lag time" of the drilling mud to travel from the surface down the hole, through the drill bit and up to the surface again (col. 1, lines 4-14).

X. Claims 2-4, 10, 15-17 and 19-21 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Hinkel and Hall and further in view of Dugstad.

The rejection of claims 2-4, 10, 15-17 and 19-20 was proposed by Requester on pages 4-8 and 35-37 of the comments filed on 2/20/2013. The proposed rejection of claims 2-4, 10, 15-17 and 19-20 **is adopted** for the following reasons. Claim 21 is included in the rejection because, as will be discussed in more detail below, the combination of Hinkel, Hall and Dugstad teaches the claimed invention.

The combination of Hinkel and Hall is relied upon for the reasons stated in IX above.

Hall also discloses that the choice of tracers is governed by the surface analytical system available, provided that the tracer species do not adsorb on the borehole wall and they are inert to the fluid components (col. 5, line 55- col. 6, line 13). Examples of traces include lithium bromide and zinc bromide.

With respect to claims 2-4, 15-17 and 19-20, the combination of Hinkel and Hall does not disclose the use of the specific tracers as claimed. However, the tracers as recited in these claims are well known in the art. For example, Dugstad teaches the use of fluorinated benzoic acids (e.g. 4-fluorobenzoic acid) and tritiated water as water tracers in a tracer program to improve the understanding of the flow dynamics and WAG (water-alternating-gas) injection efficiency in the reservoir (page 1, 1st column).

With respect to claims 10 and 21, the combination of Hinkel and Hall does not disclose the use of the specific formula as claimed for determining the amount of injected admixture recovered.

As stated above in II, Dugstad teaches the use of the same mass balance approach as described in the ‘662 patent and in claims 10 and 21 to calculate the ratio of the amount injected fluid recovered based on the tracer concentration profile.

Accordingly, it would have been obvious to one of ordinary skill in the art, searching for a suitable trace chemical to aid in determining the fluid flow characteristics in Hinkel and Hall, to select the fluorinated benzoic acid as the tracer since fluorinated benzoic acids are known to be used as a water tracer and have a higher recovery rate than other water tracers (Dugstad, page 2). In order to determine the recovery rate, one skilled in the art would have also used the formula provided by Dugstad to calculate/determine the ratio or the amount injected fluid recovered based on the tracer concentration in the recovered fluid.

XI. Claims 5-7 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Hinkel and Hall and further in view of Chen.

The above rejection was proposed by Requester on pages 4-8 and 35-37 of the comments filed on 2/20/2013. The proposed rejection **is adopted** for the following reasons.

The combination of Hinkel and Hall is relied upon for the reasons stated in IX above.

Hall also discloses that the choice of tracers is governed by the surface analytical system available, provided that the tracer species do not adsorb on the borehole wall and they are inert to the fluid components (col. 5, line 55- col. 6, line 13). Examples of

traces for use with an ion-chromatography system include lithium bromide and zinc bromide.

Hall further discloses that the concentration of the tracer in the injected fluid is sufficiently small, typically 1% by weight (10,000 ppm) (col. 5, lines 12-15).

The combination of Hinkel and Hall does not specify that the concentration range of tracer is from 100 parts per trillion to about 100 parts per million.

Chen teaches a method for determining flow patterns within a subterranean formation penetrated by an injection system and production system. The method comprises injecting into the formation a saline solution containing a small amount of one or more water-soluble tracer compounds, recovering the saline solution in the production system, determining the depth of recovery, and identifying the tracer compounds by FNMR spectroscopy (col. 1, lines 39-50).

Chen also teaches that the tracer compounds are water-soluble alkali metal salts of inorganic or organic compounds having fluorine in the anion (col. 1, lines 39-50). The amount of the tracer used in the injected solution is small and, preferably, is between about 300 to about 2000ppm (col. 2, lines 39-40). Examples of Chen show that the amount of tracer in the injected solution can be as low as 3 ppm, which are within the range as claimed.

Accordingly, it would have been obvious to one of ordinary skill in the art to use sufficiently small amount of the tracer compounds, as suggested by Chen, in the injected fluids disclosed in Hinkel and Hall in order to lower the operation cost and also reduce the negative effects that the tracers cause to the environment.

XII. Claims 5-7 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Hinkel and Hall and further in view of Hoots.

The above rejection was proposed by Requester on pages 4-8 and 35-37 of the comments filed on 2/20/2013. The proposed rejection **is adopted** for the following reasons.

The combination of Hinkel and Hall is relied upon for the reasons stated in IX above.

Hall also discloses that the choice of tracers is governed by the surface analytical system available, provided that the tracer species do not adsorb on the borehole wall and they are inert to the fluid components (col. 5, line 55- col. 6, line 13). Examples of traces for use with an ion-chromatography system include lithium bromide and zinc bromide.

Hall further discloses that the concentration of the tracer in the injected fluid is sufficiently small, typically 1% by weight (10,000 ppm) (col. 5, lines 12-15).

The combination of Hinkel and Hall does not specify that the concentration range of tracer is from 100 parts per trillion to about 100 parts per million.

Hoots teaches a method of using fluorescent tracers in a liquid system to which a treating chemical is added. The method can be utilized in a broad range of aqueous, mixed aqueous/non-aqueous, or non-aqueous liquid systems (e.g. down-hole oil field applications) (col. 3, lines 9-13). The fluorescent tracers are used to quantify and

control feed rate(s) of treating chemicals into the liquid system. In addition, the fluorescent tracers can also be used to quantify important characteristics of the liquid system such as total volume and amount of a liquid entering and leaving the system (col. 1, lines 6-16).

Hoots also teaches (col. 12, lines 61-64) that “[b]y properly choosing the fluorescing reagent, quantitative and in-situ measurement of tracer levels from parts per trillion (ppt) to parts per million (ppm) can be routinely accomplished on an instant or continuous basis with inexpensive portable equipment.”

Accordingly, it would have been obvious to one of ordinary skill in the art to use sufficiently small amount of the tracer chemicals, as suggested by Hoots, in the injected fluids disclosed in Hinkel and Hall in order to lower the operation cost and also reduce the negative effects that the tracers cause to the environment.

XIII. Claims 2-4, 15-17 and 19 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Hinkel and Hall and further in view of Bowman.

The above rejection was proposed by Requester on pages 4-8 and 35-37 of the comments filed on 2/20/2013. The proposed rejection **is adopted** for the following reasons.

The combination of Hinkel and Hall is relied upon for the reasons stated in IX above.

Hall also discloses that the choice of tracers is governed by the surface analytical system available, provided that the tracer species do not adsorb on the borehole wall and they are inert to the fluid components (col. 5, line 55- col. 6, line 13). Examples of traces for use with an ion-chromatography system include lithium bromide and zinc bromide.

The combination of Hinkel and Hall does not disclose the specific tracers as recited in claims 2-4, 15-17 and 19 as claimed.

Bowman teaches the use of water tracers including deuterated and tritiated water, bromine, chloride, and iodide in soil water. Of these common water tracers, Bowman describes that bromide is the most generally suitable tracer for soil water (page 987). In addition, a study performed by Bowman also indicates that the following tracers exhibit characteristics most similar to bromide: (i) o-(trifluoromethyl)benzoic acid (o-TFMBA), (ii) penta fluoro benzoic acid (PFBA), and (iii) 2,6- difluorobenzoic acid (2,6 - DFBA). These tracers are particularly useful in field studies when multiple tracers or totally exotic tracers are desired (page 992).

Accordingly, it would have been obvious to one of ordinary skill in the art, searching for a suitable trace chemical for use in the injected fluids disclosed in Hinkel and Hall, to select the fluorinated benzoic acids as the tracer since fluorinated benzoic acids exhibit highly desirable performance and characteristics including resistance to chemical and microbial degradation (see Bowman, page 988, 1st column) in natural environments and environments where totally exotic tracers are desired.

XIV. Claim 13 is rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Hinkel and Deans and further in view of Hall.

The above rejection was proposed by Requester on pages 4-8 and 35-37 of the comments filed on 2/20/2013. The proposed rejection **is adopted** for the following reasons.

The combination of Hinkel and Deans is relied upon for the reasons stated in I above.

Deans also discloses that the injected fluid can be an aqueous fluid, brine, or a hydrocarbon (see claims 2-4). The trace chemicals can be selected from a wide category of known and available substances, preferably, the trace chemicals should be soluble in the injected fluid and it should have little or no tendency to adsorb on or react with the matrix of the porous medium (col. 7, lines 10-21).

The combination of Hinkel and Deans does not disclose that the tracer is in the form of an encapsulated liquid or solid.

Hall, as stated in IX above, teaches that the tracers can be injected into the well as a solid or as a concentrated solution. Specifically, the tracer can be injected in the form of a compact plug of solid or dissolved material (col. 4, lines 25-33). The tracers can also be used in the form of pellets enclosed in a water-proof container (i.e. encapsulated solid) for the purpose of determining the "lag time" of the drilling mud to travel from the surface down the hole, through the drill bit and up to the surface again (col. 1, lines 4-14).

Accordingly, it would have been obvious to one of ordinary skill in the art to use tracers in the form of encapsulated solid or liquid in the process of Hinkel and Deans in order to determine the fluid flow characteristics of the drilling mud (e.g. lag time) in the well, as taught by Hall.

Response to Patent Owner's Arguments filed on 1/22/2013

In response to the first non-final Office action filed on 11/9/2012, Patent Owner presents the following arguments.

1. <u>Rejection Based on Hinkel in View of Deans</u>

A. Patent Owner argues that tracers are not a primary purpose of the Hinkel patent and the Hinkel patent is directed to the concept of first recovering fracture fluid that was injected. Its only disclosure of a tracer study is to measure whether this happens. The Hinkel patent makes no claims with respect to tracers and the Hinkel patent makes no other mention of using tracers. Similarly, tracers are not an essential part of the Deans patent (see pages 13-14 of the response filed on 1/22/2013).

As stated in I above, Hinkel clearly discloses the use of tracers to determine the recovery of the injected fluid. Hinkel describes that the tracers can be added to various fracturing fluid stages so that a tracer study can be performed to verify the effectiveness of the fracture clean-up process (see Example 4). As also stated by Requester (pages 9-10 of the comments filed on 2/20/2013),

> "[a]lthough Hinkle et al. certainly desire to know which tracer is the first one to appear at the wellhead, it is readily apparent, based upon the express goal and purposes of the Hinkle et al. process as discussed throughout the

Hinkel et al. patent, that Hinkel et al. desire to know a great deal more. For example, Hinkle et al. desire to know:

- How much fracturing fluid has been recovered (Id. at column 3, lines 5-8; column 4, lines a 30-50; and column 4 line 67 - column 5, line 4)
- How much fracturing fluid has been left in the fracture (Id. at column 2 lines 51-53)
- Whether all or most of the fracturing fluid has been recovered from the fracture tip (Id. at column 2, lines 61-64; column 3, lines 20-22 and; column 5, lines 2-5)"

Similarly, Deans also teaches the use of the tracer concentration profile as a basis to determine the amount of the injected fluid produced (recovered) (col. 6, lines 16-18). Deans describes that the principal purpose for using a tracer is to aid in determining the fluid flow characteristics such as fluid drift and dispersion of the injected fluid.

Accordingly, both Hinkel and Deans clearly teach the use of the tracers to determine the extent of recovery of the injected materials as claimed. A reference may be relied upon for all that it would have reasonably suggested to one having ordinary skill the art, including nonpreferred embodiments. *Merck & Co. v. Biocraft Laboratories*, 874 F.2d 804, 10 USPQ2d 1843 (Fed. Cir.), cert. denied, 493 U.S. 975 (1989). *See* also *Celeritas Technologies Ltd. v. Rockwell International Corp.*, 150 F.3d 1354, 1361, 47 USPQ2d 1516, 1522-23 (Fed. Cir.1998). Disclosed examples and preferred embodiments do not constitute a teaching away from a broader disclosure or nonpreferred embodiments. *In re Susi*, 440 F.2d 442, 169 USPQ423 (CCPA 1971). *See* MPEP 2123.

B. Patent Owner also argues that the Deans patent discusses reservoir "flooding" and not hydraulic fracturing. Water flooding is a very different process as compared to hydraulic fracturing. One of ordinary skill in the art would not have combined Deans with Hinkel because these two patents are incompatible in their teachings (see pages 14-16 of the response filed on 1/22/2013).

As stated above in the Claim Interpretation, claims 1 and 14 as amended do not require that the claimed method is a hydraulically fracturing process. It is also noted that the specification of the ‘662 patent does <u>not</u> describe that the inventive method only applies to a hydraulic fracturing process. In fact, the '662 patent describes that the inventive method can be used in a drilling, fracturing or any other operation requiring the injection of materials into an oil well (col. 1, line 63 - col. 2, line 2 and col. 3, lines 54-59). The '662 patent also describes that the drilling fluid can be “drilling muds” (col. 3, lines 46-48) and the inventive method can be used in a well “for water flooding in secondary recovery operations in oil and gas production” (col. 2, lines 41-43). The ‘662 patent further states that:

> “[w]hile the method of the present invention is particularly suitable for use with fracturing operations in an oil and gas well, it can be used with other types of operations and in other than just the main or primary production wellbore…. The method of the present invention can be used with almost any process wherein materials of interest are introduced to a wellbore and/or producing formation and wherein it would be desirable to be able to determine the extent that such materials have been recovered ” (col. 7, lines 53-67).

Accordingly, the '662 patent is directed to a method of using a tracer for determining the extent of recovery of materials injected into an oil well during oil and gas exploration and production, which includes drilling, fracturing and water flooding.

It has been held that a prior art reference must either be in the field of applicant's endeavor or, if not, then be reasonably pertinent to the particular problem with which the applicant was concerned, in order to be relied upon as a basis for rejection of the claimed invention. See *In re Oetiker*, 977 F.2d 1443, 24 USPQ2d 1443 (Fed. Cir. 1992).

The prior art references, Hinkel and Deans, teach the method of using tracers to determine the recovery of the injected fluids in oil and gas field operations. Hinkel teaches the use of tracers in a hydraulic fracturing and Deans teaches the use of tracers in a water flooding. Both processes are field operations requiring the injection of materials into an oil well. The '662 patent discusses the need/desire of using tracers in oil and gas field operations to determine the recovery of the injected material. The oil and gas operations include drilling, fracturing and any other operation requiring the injection of materials into an oil well (including the water flooding operation). Accordingly, Hinkel and Deans are in the same field of endeavor as the claimed invention. The teachings of Hinkel and Deans are highly pertinent to the particular problems/needs faced by Patent Owner at the time of the invention of the '662 patent. One of ordinary skill in the art, seeking to determine the recovery of the injected material in an oil well, would use the tracer concentration profiles in the produced/recovered fluid to calculate the amount of injected fluid recovered, as suggested by Deans, to determine the effectiveness of the fracture clean-up process disclosed in Hinkel.

As also argued by Requester (pages 13-14 of the comments filed on 2/20/2013):

> "[t]he teachings of Dean, Hall, and Hinkel are all indeed pertinent to the current considerations relating to the use of tracers in oilfield operations. Dean

involves water flooding, Hall involves drilling applications, and Hinkel mention use of tracers in fracturing. All three of these events (waterflooding, drilling, and hydraulic fracturing) involve the introduction of an alien fluid into a formation to enhance well production. In all three processes it is obviously important that what happens to that alien fluid in the formation can impact well productivity. From the cited work, it is taught that tracers can be used to provide needed information as to what is happening or has happened to the alien fluid in hydrocarbon formations. For example, with drilling (Hall), mud loss to a producing formation as indicated by tracers provides information concerning mud loss related to formation damage or even pending well control issues. Tracers placed into an alien fluid used for water flooding provide information about flood fronts, water breakthrough (thus bypassing production), etc. as the tracers appear at the producing well. Tracers in hydraulic fracturing (as taught by Hinkel) provide information about improvement in frac fluid returns and enhancement of the fracture system by improving polymer breaks and flow from the fracture tip."

Requester also states that (page 14 of the comments filed on 2/20/2013):

"the Patent Owner itself, in every one of its published annual reports since at least as early as 1998 (i.e. the year that the Hinkel et al. patent application was filed), has described the interrelated nature of hydraulic fracturing and flooding procedures and has noted that the two procedures are often performed in tandem. A copy of the Patent Owner's 10-K Annual Report for 1998 is appended hereto as Exhibit B."

The Patent Owner's 10-K Annual Report for 1998 (page 5) confirms that "many oilfields today are hydraulically fractured and flooded to maximize hydrocarbon recovery."

Other evidence of record also suggests that the type of tracer study described by Deans. can be used for monitoring injected fluids in numerous different downhole operations. As stated by Requester, Hoots teaches that:

"tracer study procedures can be used in all manner of downhole operations 'to quantify important characteristics of the system such as total volume and amount of liquid entering and leaving the system' (Hoots et al. column 1, lines 5-17) and, '[f]or example, oilfield applications (drilling, secondary and tertiary recovery methods, etc.)' (Id. at column 11, lines 37-38). Hoots et al. further state that: 'The invention can be utilized in a broad range of aqueous,

> mixed aqueous/non-aqueous, or non-aqueous liquid systems (e.g .... down-hole oilfield applications...) (Id. at column 3, lines 9-13)."

C. Patent Owner also cites the description of Deans at col. 7, lines 36-47 and argues that Deans teaches away from hydraulic fracturing (see pages 15-17 of the response filed on 1/22/2013).

Although Deans states, at col. 7, lines 36-47, that the injection rate should be sufficiently high so that the injected fluid can move through the formation against fluid drift and the injection rate should not be so high that the formation will fracture, this statement is specifically directed to the water flooding process. Deans also states that "the injection rate is not a significant factor in the analysis of the results because the rate of immobile fluid adsorption by the injected fluid is relatively independent of the injected fluid flow rate. The production rate should not significantly change the formation fluid pressure." Deans further states that "the injection and production rates of the fluids can be established by those skilled in the art by taking into account such factors as the reservoir conditions and injection and production facilities" (col. 7, lines 36-47).

Accordingly, Deans does not teach away from hydraulic fracturing or any other oil and gas field operations requiring the injection of materials into an oil well. One skilled in the art, when combining the teaching of Deans with Hinkel's process, would have taken into account the reservoir conditions and injection and production facilities used in Hinkel's process and establish sufficient injection and production rates of the fluids for Hinkel's process.

As also argued by Requester (page 11-12 of the comments filed on 2/20/2013),

> "Deans et al. do not teach or suggest that there is any special relationship between tracer studies and the flow rates used in waterflooding operations so that tracer studies should not be used in conjunction with hydraulic fracturing operations or other operations conducted at different flow rates. Rather, as admitted by the Patent Owner on page 13 of the Response, "tracers are not an essential part of the Deans patent." In fact, consistent with the Patent Owner's own observation, Deans et al. indicate at column 7, lines 15-18 that the presence of small amounts of chemical tracers has no bearing upon the performance, success, or failure of such operations but rather "as previously mentioned, the tracer in this invention is used only for material balance purposes and is not an essential feature of the invention."

2. <u>Rejection Based on Hinkel in View of Hall</u>

A. Patent Owner argues that Hall is unrelated to production of oil and gas from reservoirs, but instead relates to monitoring drilling mud during the drilling process. Hall does not address hydraulic fracturing. Rather, Hall teaches the use of tracers to assess dispersion of the circulating-mud in a well during drilling (see page 20 of the response filed on 1/22/2013).

For the same reasons as stated above in section 1 (A), claims 1 and 14 as amended do not require that the claimed method is a hydraulic fracturing process nor does the '662 patent describe that the inventive method only applies to the hydraulic fracturing process. In fact, the '662 patent describes that the claimed process can be a fracturing process, a drilling process and the like and the drilling fluid can be "drilling muds."

Further, Hinkel clearly discloses the use of tracers to determine the recovery of the injected fluid. Hinkel describes that the tracers can be added to various fracturing fluid stages so that a tracer study can be performed to verify the effectiveness of the fracture clean-up process (see Example 4). Hall teaches a method for monitoring

drilling mud circulation in a well wherein a tracer is added to the aqueous drilling mud. Hall describes that the amount of the injected fluid recovered from the well can be determined /calculated based on the concentration of the tracer present in the outflow fluid. Accordingly, both Hinkel and Hall teach the method of using tracers to determine the recovery of the injected fluids in oil and gas field operations (including the hydraulic fracturing or drilling process using drilling muds). Both processes are field operations requiring the injection of materials in oil and gas field operations.

As stated above, the '662 patent discusses the need/desire of using tracers in the oil and gas field operations to determine the recovery of the injected material. The oil and gas operations include drilling, fracturing and any other operation requiring the injection of materials into an oil well. Accordingly, Hinkel and Hall are in the same field of endeavor as the claimed invention. The teachings of Hinkel and Hall are highly relevant to the particular problems/needs faced by Patent Owner at the time of the invention of the ‘662 patent. One of ordinary skill in the art, seeking to determine the recovery of the injected material in an oil well, would use the tracer concentration in the produced/recovered fluid to calculate the amount of injected fluid recovered, as suggested by Hall, in order to determine the effectiveness of the fracture clean-up process disclosed in Hinkel.

B. Patent Owner also argues that the only potential determination that Hall makes is "a measure of fluid loss during circulation (provided the tracer is non-interactive with the mud components and the formation drilled)." This is exactly opposed

to the purpose of the '662 Patent which is directed to "calculating the amount of admixture recovered", not to the fluid lost during the operation (see page 20 of the response filed on 1/22/2013).

Hall discloses more than just "a measure of fluid loss during circulation". Hall discloses that the concentration of the tracer ion is measured, as a function of time, in the return mud. The residence time density function f(t) is determined from the measured concentration in order to assess the hydrodynamic dispersion of the circulating mud (col. 2, lines 29-41). Hall describes that the tracer return concentration data is processed to obtain a residence time distribution for the circulation. The time distribution is used to obtain information on the circulation.

In considering the disclosures of prior art references, it is appropriate to take into account not only the specific teachings of the references but also the inferences one skilled in the relevant art would reasonably be expected to draw therefrom. *In re Preda*, 401 F.2d 825, 826-27 (CCPA 1968), also see MPEP 2144.01.

Although Hall discloses that (col. 7, lines 6-8) the tracer concentration curve generated from the operation can be used to measure fluid loss during circulation, the amount of fluid recovered (the amount of fluid not lost) can also be determined / calculated based on the amount of the fluid loss during circulation (see Rejection IX above). Accordingly, Hall implicitly discloses that the amount of the fluid recovered from the well can be determined/calculated based on the concentration of the tracer present in the outflow fluid. It would have also been obvious to one of ordinary skill in the art to determine the amount of the fluid recovered (the amount of fluid not lost) from the well

based on the concentration of tracer present in the outflow fluid by a simple material balance, i.e. by calculating/determining the difference between the amount of the fluid injected into the well and the amount of fluid loss in the wellbore.

3. <u>Secondary Consideration</u>

A. Patent Owner presents Mr. J. Thomas Hampton's declaration and argues that Mr. Hampton demonstrates, in a claim chart (Ex. H), a correlation (nexus) between the elements of the combination of original patented claims 1 and 8 and the commercial process known as SPECTRAGHEM® as evidenced by the brochure filed with Mr. Hampton's declaration (see pages 21-23 of the response filed on 1/22/2013).

Although the SPECTRAGHEM® brochure states that SPECTRACHEM® is a patented chemical tracer technology, the brochure does not show that the technology is a process directly derived from the claimed invention recited in the '662 patent.

The brochure generally states that the SPECTRACHEM® service involves injecting tracers into different fracturing stages or segments of a single or multi-stage stimulation procedure. However, it does not describe that the process involves admixing a material with the tracers and injecting the admixture into the oil well as claimed.

The brochure also states that flowback samples are analyzed but does not specify that the flowback samples are analyzed for the concentration of the tracer present in the production fluid as claimed.

The brochure further states that the tracers are routinely used to quantify and profile fracturing fluid clean-up and flowback efficiency over time. However, the brochure does not specify that the amount of the admixture of the tracer and the injected material recovered are calculated using the concentration of the tracer present in the production fluid as a basis as claimed.

Further, the brochure does not provide any evidence of commercial success of the SPECTRAGHEM® technology. Accordingly, for the reasons stated above, the evidence provided by Patent Owner is insufficient to establish any secondary consideration based on the brochure of the commercial SPECTRACHEM® technology.

B. Patent Owner cites the Hampton declaration and argues that the subject patent satisfies a long-felt need (see pages 23-24 of the response filed on 1/22/2013).

While Mr. Hampton states in the Hampton declaration (¶ 6) that "a need existed prior to July 2001 for some diagnostic tool to determine the extent of recovery of hydraulic fracturing fluid," Mr. Hampton fails to provide sufficient evidence to show that the determination of the extent of recovery of hydraulic fracturing fluid is an art recognized problem that existed in the art for a long period of time without a solution. *See* MPEP 716.04.

The Hampton declaration cites a journal article, SPE 31094 (Ex. B), and argues that SPE 31094 recognizes the need that existed (¶ 7). However, SPE 31094 also teaches a solution to solve the identified problem. SPE 31094 teaches a more quantifiable approach than the conventional method to maximize fracture cleanup and

well productivity (see page 239 of SPE 31094). As also stated by Requester (pages 24-25 of the comments filed on 2/20/2013),

> “the article makes clear that any needs mentioned by the authors of article, whether real or imagined, were addressed and resolved in 1996 by the publication of the article itself. Consequently, any need or desire expressed in the article was resolved well prior to the Patent Owner's first commercial job in July 2001.”

Accordingly, the evidence provided by Patent Owner fails to establish that the claimed invention satisfies a long-felt need, which was recognized, persistent, and not solved by others. See MPEP 716.04.

C. Patent Owner also cites the Hampton declaration and argues that there have been many articles published in professional journals praising the benefits of the invention (see pages 24-25 of the response filed on 1/22/2013).

The cited articles, SPE 95064 (Ex. C), SEP 77750 (Ex. D), SPE 84486 (Ex. E), SPE 140105 (Ex. F), describe the use of “chemical frac tracing technology.” However, there is no evidence indicating that the chemical frac tracing technology is derived from the claimed invention.

In addition, as argued by Requester (pages 26-27 of the comments filed on 2/20/2013),

> “these articles “were all written by the Patent Owner, not by "others." Specifically: three of the five authors listed on the article of Exhibit C are employees of ProTechnics; three of the four authors listed on the article of Exhibit D are employees of ProTechnics; three of the four authors listed on the article of Exhibit E are employees of ProTechnics; and one of the two authors listed on the article of Exhibit F is an employee of ProTechnics.”

As noted by Requester, “ProTechnics” is a division of Core Laboratories (Patent Owner).

Patent Owner also provides an email comment from a customer (Ex. G). The email appears to describe field operations using tracer. However, the only “praise” from the customer related to the benefit of using tracer is that "the tracer data has really proven to be a good investment." This is insufficient to establish the nexus between the operation described in the email and the claimed invention.

D. Patent Owner cites Mr. Hamptons declaration (¶ 8) and Dr. Gary Wooley declaration (¶¶ 22-24) and argues that the invention of the ‘662 patent has been copied 3 times. The most recent is by Requester, a former employee of the patentee. There is litigation ongoing at this time regarding their infringement. There have been two other litigations. Dr. Gary’s declaration states that evidence of infringement proves that Requester copied the invention of claims 1 and 8 (¶ 24) (see page 26 of the response filed on 1/22/2013).

Patent Owner’s arguments are not persuasive. More than the mere fact of copying is necessary to make that action significant because copying may be attributable to other factors such as a lack of concern for patent property or contempt for the patentee's ability to enforce the patent. *Cable Electric Products, Inc. v. Genmark, Inc.*, 770 F.2d 1015, 226 USPQ 881 (Fed. Cir. 1985). Not every competing product that arguably falls within the scope of a patent is evidence of copying. Otherwise every

infringement suit would automatically confirm the nonobviousness of the patent." *Iron Grip Barbell Co., Inc. v. USA Sports, Inc.*, 392 F.3d 1317, 1325 (Fed. Cir. 2004).

E. Patent Owner cites the declaration of Mr. Hampton, which describes value of services, and argues that value of services shows strong evidence of commercial success of the claimed invention (see pages 25-26 of the response filed on 1/22/2013).

Although the cited declaration of Mr. Hampton states the number of jobs performed “using the invention of Amended Claims 1 and 8 of the '662 patent” and a large amount of revenues generated from the services, the declaration does not provide evidence to show that the services provided by Patent Owner correspond to the claimed process. Patent Owner bears the burden of demonstrating nexus between the objective evidence of nonobviousness and the claimed invention. *See* MPEP 716.03.

An affidavit or declaration attributing commercial success to a product or process “constructed according to the disclosure and claims of [the] patent application” or other equivalent language does not establish a nexus between the claimed invention and the commercial success because there is no evidence that the product or process which has been sold corresponds to the claimed invention, or that whatever commercial success may have occurred is attributable to the product or process defined by the claims. *Ex parte Standish*, 10 USPQ2d 1454, 1458 (Bd. Pat. App. & Inter. 1988). Also, MPEP 716.03(a)

Patent Owner also fails to show that any commercial success of the services are due to the performing of the claimed process and are not the result of other factors,

such as the result of heavy promotion/advertising or consumption by purchasers normally tied to applicant or assignee.

In considering evidence of commercial success, care should be taken to determine that the commercial success alleged is directly derived from the invention claimed, in a marketplace where the consumer is free to choose on the basis of objective principles, and that such success is not the result of heavy promotion or advertising, shift in advertising, consumption by purchasers normally tied to applicant or assignee, or other business events extraneous to the merits of the claimed invention, etc. *In re Mageli*, 470 F.2d 1380, 176 USPQ 305 (CCPA 1973) (conclusory statements or opinions that increased sales were due to the merits of the invention are entitled to little weight); *In re Noznick*, 478 F.2d 1260, 178 USPQ 43 (CCPA 1973)." Also see MPEP 716.03(b).

In addition, the revenues generated from the services provided in the declaration are also insufficient to show commercial success. Gross sales figures do not show commercial success absent evidence as to market share, *Cable Electric Products, Inc. v. Genmark, Inc.*, 770 F.2d 1015, 226 USPQ 881 (Fed. Cir. 1985), or as to the time period during which the product was sold, or as to what sales would normally be expected in the market, *Ex parte Standish*, 10 USPQ2d 1454 (Bd. Pat. App. & Inter. 1988). Also see MPEP 716.03(b) IV.

Accordingly, for the reasons stated above, Patent Owner fails to establish a nexus between the rebuttal evidence and the claimed invention.

Further, as stated above, the cited references clearly disclose the claimed method as recited in claims 1-7, 9-10 and 13-21. The evidence of secondary considerations provided by Patent Owner is insufficient to overcome the obviousness rejections of record.

Evidences pertaining to secondary considerations must be taken into account whenever present; however, it does not necessarily control the obviousness conclusion. See, e.g., *Pfizer, Inc. v. Apotex, Inc.*, 480 F.3d 1348, 1372, 82 USPQ2d 1321, 1339 (Fed. Cir. 2007) ("the record establish [ed] such a strong case of obviousness" that allegedly unexpectedly superior results were ultimately insufficient to overcome obviousness conclusion); *Leapfrog Enterprises Inc. v. Fisher-Price Inc.*, 485 F.3d 1157, 1162, 82 USPQ2d 1687, 1692 (Fed. Cir. 2007)("given the strength of the *prima facie* obviousness showing, the evidence on secondary considerations was inadequate to overcome a final conclusion" of obviousness); and *Newell Cos., Inc. v. Kenney Mfg. Co.*, 864 F.2d 757, 768, 9 USPQ2d 1417, 1426 (Fed. Cir. 1988). Also see MPEP 2145.

***Response to Patent Owner's Arguments* filed on 9/16/2013**

In response to the ACP filed on 8/16/2013, Patent Owner presents the following additional main arguments.

1. <u>Interpretation of Claims 1 and 14.</u>

A. Patent Owner argues that the claims are limited to a hydraulic fracturing process. Patent Owner states that "[i]t appears that the Examiner may be using the preamble to 'trump' the amendment. Such reasoning would be inappropriate, because

the preamble cannot be used to expand the scope of a claim." (See pages 2-4 of the response filed on 9/16/2013, emphasis in original).

Patent Owner mischaracterizes the Examiner's claim interpretation stated in the ACP mailed 8/16/2013. Claim 1 of the '662 patent recites a method for determining the extent of recovery of materials injected into an oil well. The recitation that "the material injected into the oil well is a hydraulically fracturing fluid" describes that the injected material can be a hydraulically fracturing fluid. However, the recitation does not further limit the method as claimed to be a hydraulically fracturing process. Materials useful as hydraulically fracturing fluid can also be useful for other purposes. For example, water can be used as a carrier fluid in hydraulically fracturing. Water is a hydraulically fracturing fluid. However, water is useful not only for hydraulically fracturing, but also for other purposes such as drilling and waterflooding. A method of using water as an injected material does not further limit the method to be a hydraulically fracturing process.

Claim 14 recites a method for determining the extent of recovery of a material of interest injected into an oil well. The recitation that "the material of interest injected into the oil well is a material useful for hydraulically fracturing the oil well" describes that the injected material can be used for hydraulically fracturing the oil well. However, the claim does not require that the injected material is used only for a hydraulically fracturing process. Accordingly, the claimed method recited in claim 14 is not limited to a hydraulically fracturing method.

B. Patent Owner cites the Supplemental Technical Declarations of Thomas Hampton (paragraphs 7-14) and Gary Wooley (paragraphs 7-14) and argues that it is well known in the art that these materials (the materials useful for hydraulically fracturing) are useful only for hydraulic fracturing (page 4 of the response filed on 9/16/2013).

Both the Hampton Declaration (paragraphs 7-14) and the Wooley Declaration (paragraphs 7-14) discuss the difference between hydraulic fracturing fluids and drilling fluids and state that hydraulic fracturing fluids are only used for hydraulic fracturing and drilling fluids are only for drilling. However, as stated above, the claims do not limit the injected material to be used only for hydraulic fracturing. Materials useful as hydraulic fracturing fluids can also be useful for other purposes. For example, water is a material useful for hydraulically fracturing, e.g. useful as a carrier fluid. The '662 patent discloses the use of water as a hydraulic fracturing fluid (see the Example at cols. 8-9). However, water can also be useful for other processes, such as drilling and waterflooding. Accordingly, the recitation that "the material injected into the oil well is a hydraulically fracturing fluid" or "the material of interest injected into the oil well is a material useful for hydraulically fracturing the oil well" does not further limit the claimed method to be a hydraulically fracturing method.

2. <u>Rejection Based on Hinkel in View of Deans</u>

A. Patent Owner argues that Deans is nonanalogous art and cannot be combined with Hinkel because Deans is directed to waterflooding, a completely different

field of endeavor than the hydraulic fracturing of the present claims. Water flooding operations are never mentioned in the '662 patent. Water flooding and reservoir fluid flow studies are completely different operations from hydraulic fracturing (see pages 10-11 of the response filed on 9/16/2013). Patent Owner also argues that Deans is not pertinent to the problem faced by the inventor. Patent Owner states that the contrast between hydraulic fracturing and waterflooding is such that any solutions found in the waterflooding arts have no relevance to the problems faced by those in the hydraulic fracturing arts. Further, Patent Owner cites a document downloaded from the website FracFocus.org and states that hydraulic fracturing is not a "drilling process." (pages 12-13 of the response filed on 9/16/2013).

As stated in MPEP 2141.01(a):

> "Under the correct analysis, any need or problem known in the field of endeavor at the time of the invention and addressed by the patent [or application at issue] can provide a reason for combining the elements in the manner claimed." *KSR International Co. v. Teleflex Inc.,* 550 U.S. ** > 398,420, 82 USPQ2d 1385, 1397 (2007). "This does not require that the reference be from the same field of endeavor as the claimed invention, in light of the Supreme Court's instruction that '[w]hen a work is available in one field of endeavor, design incentives and other market forces can prompt variations of it, either in the same field or a different one.' KSR Int'l Co. v. Teleflex Inc., 550 U.S. 398, 417 (2007). Rather, a reference is analogous art to the claimed invention if: (1) the reference is from the same field of endeavor as the claimed invention (even if it addresses a different problem); or (2) the reference is reasonably pertinent to the problem faced by the inventor (even if it is not in the same field of endeavor as the claimed invention). *See Bigio*, 381 F.3d at 1325." (Emphasis added).

Accordingly, a reference is analogous art to the claimed invention if it meets one of the requirements as stated above in MPEP 2141.01(a).

Deans is analogous art because Deans is from the same field of endeavor as the claimed invention. The claims of the '662 patent recite a method for determining the

extent of recovery of materials injected into an oil well. The ‘662 patent describes that the inventive method can be used in a drilling, fracturing or any other operation requiring the injection of materials into an oil well (col. 1, line 63 – col. 2, line 2 and col. 3, lines 54-59). The drilling fluid can be “drilling muds” (col. 3, lines 45-47). The ‘662 patent also states that the inventive method can be used in a well “for water flooding in secondary recovery operations in oil and gas production” (col. 2, lines 40-42, emphasis added). The ‘662 patent further states that “[t]he tracers useful for the inventive method include any known to those ordinary skill in the art of using chemical tracers in oil and gas operations to be useful” (col. 3, line 64-col. 4, line 23). Accordingly, the claimed invention of the ‘662 patent is directed to a method of using a tracer for determining the extent of recovery of materials injected into an oil well for field operations such as drilling, fracturing and water flooding.

Both the cited references, Hinkel and Deans, teach the method of using tracers to determine the recovery of injected fluids in oil and gas field operations. Hinkel teaches the use of tracers in a hydraulic fracturing process. Deans teaches the use of tracers in a water flooding process. Both processes are field operations requiring the injection of materials into an oil well. Accordingly, both processes are in the same field of endeavor as the claimed invention recited in the ‘662 patent.

Further, even if the water flooding process described in Deans is a different operation from hydraulic fracturing process as argued by Patent Owner, Deans is also pertinent to the particular problems/needs faced by Patent Owner at the time of the invention of the ‘662 patent. The ‘662 patent discusses the need/desire of using an

inexpensive and environmentally benign method in oil and gas productions to determine the recovery of the injected material after a drilling, fracturing or any other operation requiring the injection of material into an oil well (col. 1, line 63 - col. 2, line 2). Deans teaches the use of tracer concentration profiles in the produced fluid to determine/calculate the amount of injected fluid recovered. Specifically, Deans teaches that the concentration of the tracer in the produced fluid can be measured and used for material balance purposes to determine the fluid flow characteristics including using the tracer concentration profile as a basis to determine the amount of the injected fluid produced (recovered). Deans clearly describes a tracer study which is pertinent to the particular problems/need faced by Patent Owner. Accordingly, Deans is analogous art to the claimed invention of the ‘662 patent.

B. Patent Owner argues that engineers and geologists who design water flooding operations or fluid flow studies are not the same people who design fracturing operations. Considering waterflooding and hydraulic fracturing as analogous simply ignores the technical and commercial differences between these two technologies (page 11 of the response filed on 9/16/2013).

Patent Owner’s arguments are not persuasive for the same reasons as stated above in section 2A. The determination of analogous art is not based on whether the waterflooding and hydraulic fracturing operations are designed by the same or different engineers and geologists. As stated above in section 2A, Deans is analogous art because (1) Deans is from the same field of endeavor as the claimed invention and (2)

Deans is also pertinent to the particular problems/needs faced by Patent Owner at the time of the invention of the ‘662 patent.

Further, as also argued by Requester (pages 17-18 of the comments filed on 10/7/2013):

> In further response to the contention of the Patent Owner regarding the isolation of fracturing engineers and their asserted lack of knowledge and awareness concerning other oil-field operations, Mr. Alfred Jennings explains in ¶¶ 8-11 of his Supplemental Declaration (Requester's Exhibit G) concerning drilling, cementing, perforating, fracturing, flooding, and other stimulation and enhanced recovery operations that:
>
> > Depending upon the size of the oil and gas operating company, a staff of operations engineers, production engineers, and well completions engineers may handle every aspect of the well completions described above. In small companies, only a few engineers may be available to handle the myriad of operations necessary to produce oil and gas. Regardless of the number of engineers involved in a particular field, team meetings, technical presentations, etc. are periodically held to provide information and to discuss ideas concerning the various aspects of oil and gas well operations.
> >
> > Since fluids not commonly found in producing formations must be used during many phases of well operations, the recovery and accounting of fluid volumes used are inherent in many of the well completions operations. This is true with drilling, cementing, perforating, workovers, hydraulic fracturing and other stimulation operations. It is also important with secondary recovery operations such as waterflooding, because of formation heterogeneities where certain higher permeability zones can cause premature water breakthrough in producing wells.
> >
> > Rather than being separate technologies handled by completely different sets of professionals, oftentimes well issues will be discussed in group or team format to draw from the experiences and knowledge of others within the company. For example, hydraulic fracturing is often used in water injection wells to improve injection rates. Fracturing can also be used in special applications to improve injection well profiles to improve sweep efficiency in lower permeability intervals. Tracers are frequently used to measure injection profiles in water injection wells.

> Tracer technology borrowed from waterflooding is also employed in hydraulic fracturing applications in parallel laterals where one lateral represents a producing well and tracers may be injected during fracturing of a second (offset) parallel lateral. The reason for injecting tracers into the newly fractured well is to determine fracture to fracture interference with the producing well.

C. Patent Owner also argues that the tracer arts are too unpredictable to justify combining Hinkel with Deans because there are no “finite” or limited solutions available to those skilled in the art. Patent Owner also refers to the cited references and argues that the present record here provides ample evidence that tracers have been put to a multitude of uses--many of which required extensive experimentation to implement (pages 13-17 of the response filed on 9/16/2013).

Patent Owner’s arguments are not persuasive. The cited references, Hinkel, Deans and Hall, disclose that tracers can be used in field operations such as fracturing (Hinkel), waterflooding (Deans) and drilling (Hall). The ‘662 patent also describes that the inventive method can be put to the same “multitude of uses”, i.e., drilling, fracturing, and water flooding. In fact, the ‘662 patent discloses that the inventive method can be used for other processes in addition to the three processes stated above. The ‘662 patent states that the inventive method can be used in <u>a drilling, fracturing or any other operation requiring the injection of materials into an oil well</u> (col. 1, line 63 – col. 2, line 2 and col. 3, lines 54-59). The ‘662 patent also describes that the drilling fluid can be “drilling muds” (col. 3, lines 45-47) and the inventive method can be used in a well “for water flooding in secondary recovery operations in oil and gas production” (col. 2, lines 40-42). Accordingly, hydraulic fracturing, waterflooding and drilling processes are all

within the scope of the claimed invention of the ‘662 patent. Contrary to Patent Owner's arguments, there is no discussion in the ‘662 patent that the tracer arts are too unpredictable to the “multitude of uses”. The ‘662 patent states that “<u>[t]he tracers useful for the inventive method include any known to those ordinary skill in the art of using chemical tracers in oil and gas operations to be useful</u>” (col. 3, line 64-col. 4, line 23, emphasis added).

Patent Owner's arguments with respect to the individual cited reference (see pages 13-17 of the response filed on 9/16/2013) are also not persuasive for the following reasons.

<u>Deans</u>

a) Patent Owner argues that the injection rate and pressure in Deans are intentionally kept low in order to avoid fracturing the formation by exceeding the formation fracture strength. Patent Owner further argues the concentration of tracer in the injected fluid ranges from about one-half to two percent by volume and is a much higher tracer concentration than the invention of the ‘662 patent, which describes the use of a concentration of 1000 parts per million.

Deans does not intentionally keep the injection rate and pressure low in order to avoid fracturing the formation. Rather, Deans discloses that “the injection rate is not a significant factor in the analysis of the results because the rate of immobile fluid adsorption by the injected fluid is relatively independent of the injected fluid flow rate. The production rate should not significantly change the formation fluid pressure.” Deans further states that “the injection and production rates of the fluids can be

established by those skilled in the art by taking into account such factors as the reservoir conditions and injection and production facilities" (col. 7, lines 36-47).

As also argued by Requester (page 10 of the comments filed on 10/7/2013):

> In other words, the teaching of Deans et al. concerning tracer studies is that a tracer study is merely a tool for analyzing the results of an oilfield operation. Deans et al. also make clear at column 7, lines 43-45 that, regardless of the preferred injection rates for water flooding, the actual injection rate used in the practice of the process is not a significant factor in the analysis of the results.

With respect to the concentration range of the tracer in the injected fluid, Patent Owner's arguments are not commensurate with the scope of claims 1-4, 9-10 and 13-21 since these claims do not require the specific concentration as argued by Patent Owner. With respect to the remaining claims, claim 5 recites that the tracer is present in the injected mixture at a concentration of at least about 1 part per trillion. Claim 6 depends on claim 5. Claim 6 recites that the tracer is present in the injected mixture at a concentration of less than or equal to 10,000 ppm. Deans discloses, as a matter of economics, that the concentration of the tracer in the injected fluid ranged from about one half to two percent by volume (5000 - 20,000 ppm) (col. 7, lines 33-35). The tracer concentration disclosed in Deans is in the same range as recited in claims 5-6 of the '662 patent. Further, Deans states that the concentration of the tracer is determined based on economic consideration. Accordingly, the teachings of Deans would have led one skilled in the art to use lower concentration in order to reduce the cost. Claim 7 recites that the concentration of the tracer is from 100 ppt to about 100 ppm. As stated above in the Claim Rejections section, the combination of Hinkel, Deans and one of the

additional cited references, Chen, Hoots or Greenkorn, teaches the concentration range recited in claim 7.

b) Patent Owner also argues that hydraulic fracturing is most commonly applied to unconventional reservoirs such as shale formations and is not intended to sweep an area of the reservoir as waterflooding does. Instead the injected fracture fluid returns to the surface in the same wellbore into which it was injected.

Patent Owner's arguments are not commensurate with the scope of the claims since the claims of the '662 patent do not require that the claimed method is a hydraulic fracturing.

Patent Owner's arguments are also not persuasive for the same reasons as stated above in section 2A. Specifically, as stated above, the claimed invention of the '662 patent is directed to a method of using a tracer for determining the extent of recovery of materials injected into an oil well for field operations such as drilling, fracturing and water flooding. Both waterflooding and hydraulic fracturing are within the scope of the claimed invention of the '662 patent.

Additionally, as argued by Requester (pages 6-7 of the comments filed on 10/7/2013):

> Contrary to the assertions of the Patent Owner and its expert, the Hinkel et al. procedure is used in both conventional (high permeability) and unconventional (low permeability) formations. As stated by Hinkel et al. at Column 2, lines 26-43:
>
> > [H]ydraulic fracturing is a common means to stimulate hydrocarbon production in low permeability formations**. <u>In addition, fracturing has also been used to stimulate production in high permeability formations.</u>** Obviously, if fracturing is desirable in a particular instance, then it is also desirable, generally speaking, to create as large (i.e., long) a

> fracture zone as possible--e.g., a larger fracture means an enlarged towpath from the hydrocarbon migrating towards the wellbore and to the surface.
>
> Moreover, as further evidence of the importance of the Hinkel et al. process for conventional (high permeability) formations, Hinkel et al. also state at Column 4, lines 25-37 that:
>
> > [I]t is desirable to remove the fracturing fluid from the fracture--its presence in the fracture is deleterious, since it plugs the fracture and therefore impedes the flow of hydrocarbon. **<u>This effect is naturally greater in high </u>permeability formations, since the fluid can readily fill the (larger) void spaces**. (Emphasis in original).

With respect to the argument that "the injected fracture fluid returns to the surface in the same wellbore into which it was injected," Requester states the following (pages 10-11 of the comments filed on 10/7/2013):

> Concerning yet another misstatement by the Patent Owner regarding Deans et al., the Patent Owner argues on page 14 of its Response that Deans et al. is distinguishable from hydraulic fracturing because fracturing fluid is recovered from the same wellbore into which it was injected whereas the Deans et al. fluid is not. However, contrary to the Patent Owner's contention, the Abstract of the Deans et al. patent states that: "The injected fluid is then preferably produced from the formation by means of the injection well."
>
> Moreover, not only is the Patent Owner's statement incorrect in regard to the actual teaching of Deans et al., but the Patent Owner is also incorrect in asserting that a fracturing fluid will always be recovered from the same well into which it was injected. For example, as explained in ¶ 11 of the Supplemental Declaration of Alfred Jennings (Requester's Exhibit G):
>
> > Tracer technology borrowed from waterflooding is also employed in hydraulic fracturing applications in parallel laterals where one lateral represents a producing well and tracers may be injected during fracturing of a second (offset) parallel lateral. The reason for injecting tracers into the newly fractured well is to determine fracture to fracture interference with the producing well.

Further, it is noted that the claims of the '662 patent do not require that the injected fluid returns to the surface through the same well into which it was injected. For

example, claim 1 recites “an offset well associated with an oil well," which is different from the oil well. The admixture is injected into the offset well but recovered from the oil well. Similarly, claims 18 and 20 recite that the tracer is introduced into an offset well and recovered from the oil well.

c) Patent Owner also argues that the Deans method is not described as being capable of making a distinction as to which fluid from a particular region in a fracture is the first to be recovered from a well. One skilled in the art would understand that Deans has no disclosure or suggestion that it can be used to verify differential mobility of fluids in a well as required by the tracer study described in Hinkel.

Again, Patent Owner’s argument is not commensurate with the scope of the claims since the claims of the ‘662 patent do not require that the claimed method to “make a distinction as to which fluid from a particular region in a fracture is the first to be recovered from a well.”

Patent Owner’s argument is also inconsistent with the disclosure of the ‘662 patent. The ‘662 patent describes that the inventive method can be used in a drilling, fracturing or any other operation requiring the injection of materials into an oil well (col. 1, line 63 – col. 2, line 2 and col. 3, lines 54-59). The ‘662 patent states that “[t]he tracers useful for the inventive method include any known to those ordinary skill in the art of using chemical tracers in oil and gas operations to be useful” (col. 3, line 64-col. 4, line 23). Accordingly, the tracer study described in the ‘662 patent can be used in field operations including the hydraulic fracturing described in Hinkel and the waterflooding described in Deans.

Further, Patent Owner's argument is unpersuasive with respect to the teachings of Hinkel and Deans.

Hinkel discloses a fracture clean-up process which involves recovering the injected fluid from the fracture (col. 3, lines 9-19 and Examples). Hinkel describes that the method for fracturing comprises a suite of breakers or a single breaker at varying concentrations, to induce a mobility gradient, such that fracturing fluid near a fracture tip has a higher differential mobility (DM) than fracturing fluid near the well bore (Claim 1). In Example 4, Hinkel states that:

> The effectiveness of DM treatments are simple to verify in actual field applications. For instance, a tracer study can be performed whereby small amounts of tracers are added to different stages of the fracturing fluid. If the method of the present Invention is operable then the tracer study should indicate the first fluid injected flows back sooner compared with the remainder of the fluid, compared with conventional treatments.

As indicated above, the tracer study described in Hinkel is simply a tool that is intended to be used to verify the effectiveness of the fracturing process in actual field operations. Hinkel describes that the tracer study is performed by (1) adding small amounts of tracer to different stages of the fracturing fluid and (2) analyzing the recovered fluid to determine the effectiveness of the fracturing process. Hinkel does not design a new tracer process. Using a tracer study to verify the recovery of injected fluids in a field operation is well known in the art. Hinkel simply uses the known tracer study as a tool to determine the effectiveness of the fracturing process. Similarly, Deans also discloses a method of using a tracer study as a tool for analyzing a process in field operations. Specifically, Deans describes that the tracer study uses the tracer concentration profile as a basis to determine the amount of the injected fluid produced

(recovered). Accordingly, it would have been obvious to one of ordinary skill in the art, seeking to further improve the tracer study used in Hinkel, to apply the tracer study suggested by Deans in order to determine/calculate the recovery of the injected fluids in Hinkel's process. In other words, using the tracer concentration profile method as suggested by Deans in Hinkel's fracturing process to determine the amount of the injected fluid recovered from different stages of the fracturing fluid ("differential mobility of the fluids") would have been obvious to one of ordinary skill in the art.

Further, as also argued by Requester (page 11 of the comments filed on 10/7/2013):

> In addition, on pages 14 and 17, the Patent Owner attempts to argue that Deans et al. and Hall are not compatible with hydraulic fracturing because they are not described as being capable of making a distinction as to which fluid came from a particular region. However, this is not a requirement of any of the claims of the '662 patent. Moreover, as will be discussed more fully below, accomplishing the task of distinguishing between stages is already explained by the Hinkel et al. reference which teaches that the result is obtained by putting a different tracer in each stage. In addition, many of the other references of record, particularly those cited against tracer claims 2-7, 15 and 16 of the '662 patent, disclose numerous alternative tracers which are separately detectable, including the Bowman reference which states in the Abstract thereof that: "These latter three fluorobenzoates show promise as laboratory and field tracers of soil water, <u>particularly where multiple tracing tests or totally exotic tracers </u>are required." (Emphasis in original).

<u>Hinkel</u>

Patent Owner argues that Hinkel discloses various fluids be injected into the formation at a rate of 45 barrels per minute (approximately 7 m^3 per minute) to create a fracture zone. This injection rate is much higher than the injection rates typically used for water flooding or fluid flow applications. Hinkel is silent regarding the amount and

type of tracer used, and mentions tracers only in passing as a way of verifying that the fluid from the fracture tips is flowing back sooner than the remainder of the fluid.

Patent Owner's argument with respect to the injection rate is not commensurate with the scope of the claims. The instant claims do not require a specific injection rate nor does the specification of the '662 patent discuss any injection rate that is critical/important to the inventive method of using tracer to determine the extent of recovery of the materials injected into an oil well.

Patent Owner's argument is also inconsistent with the disclosure of the '662 patent. The '662 patent describes that the inventive method can be used in a drilling, fracturing or any other operation requiring the injection of materials into an oil well (col. 1, line 63 – col. 2, line 2 and col. 3, lines 54-59). Accordingly, both the hydraulic fracturing process described in Hinkel and the waterflooding process described in Deans are within the scope of the claimed invention of the '662 patent.

Further, in response to the argument that Hinkel is silent regarding the amount and type of tracer used, Patent Owner cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.,* 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). In this case, as stated above in the Claim Rejections section, the combination of the cited references teaches the amount and type of the tracer used. For example, the combination of Hinkel and Deans teaches the amount of the tracer as recited in claims 5-6. The combination of Hinkel, Deans and Dugstad teaches the amount and type of tracer as recited in claims 2-4, 10 and 15-21.

The combination of Hinkel, Deans and one of the additional cited references, Chen, Hoots, or Greenkorn, teaches the amount of tracer as recited in claims 5-7.

Dugstad

a) Patent Owner argues that Dugstad discusses the use of various tracers in connection with a Water-Alternating-Gas ("WAG") application. Among other data gathered by Dugstad was the "breakthrough time" between the tracer injection and the time when the first sample containing that tracer was collected. Breakthrough time for the various tracers varied from 37 days to nearly 5 years. These lengthy "breakthrough times" are not seen in hydraulic fracturing operations, where the recovery of fracturing fluids typically begins very soon after the start of production. Patent Owner also argues that tracers are suggested to test the purpose of the Dugstad invention, which is to change the mobility of trapped oil as a result of injecting gas such as carbon dioxide. Flushing a conventional reservoir according to the teachings of Dugstad is very different from hydraulic fracturing where injected fracture fluid returns to the surface through the same wellbore into which it was injected.

Again, Patent Owner's argument is not commensurate with the scope of the claims since the claims of the ‘662 patent do not require a quick recovery time or a short breakthrough time nor does the specification of the ‘662 patent discuss any recovery time or breakthrough time that is critical/important to the inventive method of using tracer to determine the extent of recovery of the materials injected into an oil well.

Patent Owner’s argument is also inconsistent with the disclosure of the ‘662 patent. The ‘662 patent describes that the inventive method can be used in a drilling,

fracturing or any other operation requiring the injection of materials into an oil well (col. 1, line 63 – col. 2, line 2 and col. 3, lines 54-59). Accordingly, the processes described in Hinkel, Deans and Dugstad are all within the scope of the claimed invention of the ‘662 patent.

With respect to the argument that the injected fracture fluid returns to the surface through the same wellbore into which is was injected, Patent Owner’s argument is not persuasive for the same reasons as stated above with respect to **Deans** under section b).

Chen

Patent Owner argues that Chen teaches improved tracers for use in determining fluid flow patterns in subterranean formations. Fluid is injected into the formation slowly, at a rate of approximately 2.4 ml/hour. The fluid is injected into an injection well, and then samples are taken from one or more production wells. Col. 1, lines 60-67. Slow (low pressure to avoid fracture) injection of fluid to sweep a conventional reservoir is very different than high pressure injection for the purpose of causing a fracture. Fracture fluid does not travel through the formation to be produced from a different well than it was injected (pages 14-15 of the response filed on 9/16/2013).

Patent Owner's arguments are unpersuasive for the same reasons as stated above with respect to **Hinkel**. Specifically, the process disclosed in Chen is within the scope of the claimed invention of the ‘662 patent. Patent Owner’s argument with respect to the injection rate described in Chen is not commensurate with the scope of the claims since the claims of the ‘662 patent do not require a specific injection rate. In

addition, there is no discussion in Chen that the injected rate is set slowly to prevent fracture.

With respect to the argument that fracture fluid does not travel through the formation to be produced from a different well than it was injected, Patent Owner's argument is not persuasive for the same reasons as stated above with respect to **Deans** under section b).

Hoots

Patent Owner argues that Hoots teaches the use of fluorescent tracers in a liquid system to which a treating chemical is added. The fluorescent tracers are used in very low concentrates of around 200 ppm to parts per trillion.

Patent Owner's argument is not persuasive for the same reasons as stated above with respect to **Deans** under section a). Specifically, only claims 5-6 require that the tracer is present in the mixture at a specific concentration. Claim 5 recites that the tracer is present in the injected mixture at a concentration of at least about 1 part per trillion. Claim 6 depends on claim 5. Claim 6 recites that the tracer is present in the injected mixture at a concentration of less than or equal to 10,000 ppm. Deans discloses, as a matter of economics, that the concentration of the tracer in the injected fluid ranged from about one half to two percent by volume (5000 - 20,000 ppm) (col. 7, lines 33-35). The tracer concentration disclosed in Deans is in the same range as recited in claims 5-6. Further, Deans states that the concentration of the tracer is determined based on economic consideration. Accordingly, the teachings of Deans would have led one skilled in the art to use lower concentration in order to reduce the

cost. Claim 7 recites that the concentration of the tracer is from 100 ppt to about 100 ppm. As stated above in the Claim Rejections section, the combination of Hinkel, Deans and Hoots teaches the concentration range recited in claim 7.

Teasdale

Patent Owner argues that Teasdale teaches the use of tracers to determine the fluid drift rate within a reservoir. A discrete slug of fluid with tracer is slowly injected (to prevent fracture) into the formation at the rate of about 32 m^3 per day. By contrast fracture fluid is injected at high pressure to create a fracture.

Patent Owner's arguments are unpersuasive for the same reasons as stated above with respect to **Hinkel**. Specifically, the process disclosed in Teasdale is within the scope of the claimed invention of the ‘662 patent. Patent Owner’s argument with respect to the injection rate described in Teasdale is not commensurate with the scope of the claims since the claims of the ‘662 patent do not require a specific injection rate. In addition, there is no discussion in Teasdale that the injected rate is set under low pressure to avoid fracture.

Greenkorn

Patent Owner argues that Greenkorn teaches the selection of specific tracers to locate flow paths through a reservoir for water flooding applications. In a field test, the fluid was slowly injected into the well at a rate of approximately 1.5 m^3 per day. There are differences between waterflooding at low pressure to avoid fracture and injecting fracture fluids at high pressure to cause fractures.

Again, Patent Owner's arguments are unpersuasive for the same reasons as stated above with respect to **Hinkel**. Specifically, the process disclosed in Greenkorn is within the scope of the claimed invention of the ‘662 patent. Patent Owner’s argument with respect to the injection rate described in Greenkorn is not commensurate with the scope of the claims since the claims of the ‘662 patent do not require a specific injection rate. In addition, there is no discussion in Greenkorn that the injected rate is set under low pressure to avoid fracture.

Bowman

Patent Owner argues that Bowman teaches the selection of specific tracers for use in soil water studies. One of the tracers under consideration, SCN-, was of interest because it had previously been successfully used to follow water movement in oil-bearing formations. Page 987. However, Bowman concluded that SCN- was "not a suitable soil water tracer even for short-term studies, due to rapid chemical and/or biological transformation." Page 992. This demonstrates that a tracer that is useful for one application may not be useful for other applications (page 16 of the response filed on 9/16/2013).

Patent Owner’s arguments are not commensurate with the scope of claims 1, 5-7, 9-10, 13-14 and 21 since these claims do not recite any specific tracer.

With respect to claims 2-4 and 15-20, Patent Owner's arguments are not persuasive. Bowman clearly teaches the benefits of using the specific tracer as claimed in similar environments. One skilled in the art, searching for a suitable trace chemical for use in the injected fluids disclosed in Hinkel and Deans, would select the tracers,

such as fluorinated benzoic acids, as suggested by Bowman, because these tracers exhibit highly desirable performance and characteristics including resistance to chemical and microbial degradation (see Bowman, page 988, 1st column).

Further, Patent Owner's argument that "a tracer that is useful for one application may not be useful for other applications" is inconsistent with the disclosure of the '662 patent. The '662 patent describes that the inventive method can be used in a drilling, fracturing or any other operation requiring the injection of materials into an oil well (col. 1, line 63 – col. 2, line 2 and col. 3, lines 54-59). Contrary to Patent Owner's argument, the '662 patent clearly indicates that "<u>[t]he tracers useful for the inventive method include any known to those ordinary skill in the art of using chemical tracers in oil and gas operations to be useful</u>" (col. 3, line 64 - col. 4, line 23, emphasis added).

<u>Hall</u>

Patent Owner argues that Hall relates to using tracers to monitor the circulation of drilling mud in a well during a drilling operation. The tracer is injected into the drilling mud in discrete doses. This differs from hydraulic fracturing operations, wherein the tracer is typically admixed continuously into the stream of injected fracturing fluid. The residence time density function of the tracer is calculated in order to characterize the circulation of fluid in the wellbore. The Hall method is not described as being capable of making a distinction as to which fluid from a particular region in a well is the first to be recovered from a well. Instead, the Hall method is described as only providing information regarding mud circulation. Hall has no disclosure or suggestion that it can

be used to verify differential mobility of fluids in a well as required by the tracer study described in Hinkel (page 17 of the response filed on 9/16/2013).

Patent Owner's arguments are not commensurate with the scope of the claims since the claims of the '662 patent do not require that the claimed method is a hydraulic fracturing process or a process for verifying differential mobility of fluids in a well. The claims of the '662 patent recite a method of using a tracer for determining the extent of recovery of materials injected into an oil well from any field operations (e.g. hydraulic fracturing, drilling and waterflooding).

Patent Owner's arguments are also inconsistent with the disclosure of the '662 patent. The '662 patent describes that the inventive method can be used in a drilling, fracturing or any other operation requiring the injection of materials into an oil well (col. 1, line 63 – col. 2, line 2 and col. 3, lines 54-59). The '662 patent also describes that the drilling fluid can be "drilling muds" (col. 3, lines 45-47). The '662 patent also states that "[t]he tracers useful for the inventive method include any known to those ordinary skill in the art of using chemical tracers in oil and gas operations to be useful" (col. 3, line 64 - col. 4, line 23). Accordingly, both hydraulic fracturing process disclosed in Hinkel and the drilling process disclosed in Hall are within the scope of the claimed invention recited in the '662 patent.

Further, Patent Owner's arguments are also unpersuasive with respect to the teachings of Hinkel and Hall.

Hinkel discloses a fracture clean-up process which involves recovering the injected fluid from the fracture (col. 3, lines 9-19 and Examples). Hinkel describes that

the method for fracturing comprising a suite of breakers or a single breaker at varying concentrations, to induce a mobility gradient, such that fracturing fluid near a fracture tip has a higher differential mobility (DM) than fracturing fluid near the well bore (Claim 1). In the Example 4, Hinkel states that:

> The effectiveness of DM treatments are simple to verify in actual field applications. For instance, a tracer study can be performed whereby small amounts of tracers are added to different stages of the fracturing fluid. If the method of the present Invention is operable then the tracer study should indicate the first fluid injected flows back sooner compared with the remainder of the fluid, compared with conventional treatments.

As indicated above, the tracer study described in Hinkel is simply a tool that is intended to be used to verify the effectiveness of the fracturing process in actual field operations. Hinkel describes that the tracer study is performed by (1) adding small amounts of tracer to different stages of the fracturing fluid and (2) analyzing the recovered fluid to determine the effectiveness of the fracturing process. Hinkel does not design a new tracer process. Using a tracer study to verify the recovery of injected fluids in a field operation is well known in the art. Hinkel simply uses the known tracer study as a tool to determine the effectiveness of the fracturing process. Similarly, Hall also teaches a tracer study as a tool for analyzing a process in field operations. Hall teaches a method for monitoring drilling mud circulation in a well wherein a tracer is added to the aqueous drilling mud. More specifically, Hall describes a preferred operation involves injecting a quantity of tracer into the mud inlet at the surface; detecting quantitatively the time variation of the tracer concentration as it returns to the surface; processing the tracer return concentration data to obtain a residence time distribution for the circulation; using the time distribution to obtain information on the

circulation. Accordingly, it would have been obvious to one of ordinary skill in the art, seeking to further improve the tracer study used in Hinkel, to apply the tracer technique suggested by Hall in order to determine/calculate the recovery of the injected fluids in Hinkel's process. In other words, using the tracer concentration time distribution method as suggested by Hall in Hinkel's fracturing process to determine the extent of the injected fluid recovered from different stages of the fracturing fluid ("differential mobility of the fluids") would have been obvious to one of ordinary skill in the art.

As also argued by Requester (page 11 of the comments filed on 10/7/2013):

> In addition, on pages 14 and 17, the Patent Owner attempts to argue that Deans et al. and Hall are not compatible with hydraulic fracturing because they are not described as being capable of making a distinction as to which fluid came from a particular region. However, this is not a requirement of any of the claims of the '662 patent. Moreover, as will be discussed more fully below, accomplishing the task of distinguishing between stages is already explained by the Hinkel et al. reference which teaches that the result is obtained by putting a different tracer in each stage. In addition, many of the other references of record, particularly those cited against tracer claims 2-7, 15 and 16 of the '662 patent, disclose numerous alternative tracers which are separately detectable, including the Bowman reference which states in the Abstract thereof that: "These latter three fluorobenzoates show promise as laboratory and field tracers of soil water, <u>particularly where multiple tracing tests or totally exotic tracers</u> are required." (Emphasis in original).

D. Patent Owner states that the solutions offered by tracer studies vary on almost a case-by-case basis. The fact that a particular tracer study may have provided a solution for one type of application--for example, assessing fluid flow through a reservoir--has no bearing on whether that solution would predictably and with a reasonable expectation of success solve a problem in the hydraulic fracturing arts (pages 17-18 of the response filed on 9/16/2013).

Patent Owner's arguments are not persuasive for the same reasons as stated above in section 2C. As stated above, the cited references show that the tracer studies can be used in various applications (drilling, fracturing, waterflooding, etc.) to provide the same solution, i.e. determining the extent of the recovery of materials injected into an oil well. This is also confirmed by the disclosure of the '662 patent. The '662 patent states that the inventive method can be used in a drilling, fracturing or any other operation requiring the injection of materials into an oil well and the tracers useful for the inventive method can be any chemical tracers known to be useful in oil and gas operations.

Additionally, as stated above in the Claim Rejections section, all the claimed elements were known in the prior art and one skilled in the art could have combine the elements as claimed by known methods with no change in their respective functions, i.e. using the tracer for determining the extent of recovery of materials injected into an oil well, and the combination would have yielded nothing more than predictable results to one of ordinary skill in the art. *KSR International Co. v. Teleflex Inc.*, 550 U.S. ___, ___, 82 USPQ2d 1385, 1395 (2007). Also see MPEP2143.02. Accordingly, the teachings of the prior art clearly provide a sufficient basis for a reasonable expectation of success.

E. Patent Owner also argues that the Examiner, in making this combination of references, is engaging in mere "picking and choosing" in hindsight. This is in marked contrast to the requirement that the Examiner must combine known options into

a finite number of identified predictable solutions as is required under KSR Int'l Co. v. Teleflex Inc., 550 U.S. 398,421 (2007)) (pages 18-19 of the response filed on 9/16/2013).

Patent Owner’s arguments are not persuasive. The claim rejections stated above are not based on mere “picking and choosing” in hindsight as argued by Patent Owner. Rather, the claim rejections are based on applying a known technique to a known method to improve methods or products in the same way or yield predictable results. *KSR International Co. v. Teleflex Inc.*, 550 U.S. ___, ___, 82 USPQ2d 1385, 1395-97 (2007). In the rejection of the independent claims based on Hinkel in view of Deans, the prima facie case of obviousness is established based on applying the known tracer study disclosed in Deans to Hinkel to further improve the tracer study in Hinkel’s process. Similarly, in the rejection of the independent claims based on Hinkel in view of Hall, Hall also provides a known tracer technique which would have been obvious to one of skill in the art to use for improving the tracer study disclosed in Hinkel. In the rejections of the depending claims, each of the additional references further provides a known predictable solution to the process disclosed in Hinkel in view of Deans or Hinkel in view of Hall. Accordingly, the claim rejections clearly meet the prima facie case of obviousness requirements under KSR.

F. Patent Owner also argues that modifying Hinkel with Deans renders Hinkel unsatisfactory for its intended purpose (pages 19-20 of the response filed on 9/16/2013). Patent Owner states that:

> The intended purpose of the tracer study in Hinkel is to determine whether or not the fluid in the distal end of a fracture is the first fluid that is recovered. However, the tracer method of Deans is only used to determine fluid drift, fluid mobility, and the volume of fluid that has been recovered from the well (Declaration of Gary Wooley, Paragraph 17(a)). The Deans method is not described as being capable of making a distinction as to which fluid from a particular region in a fracture is the first to be recovered from a well (Declaration of Gary Wooley, Paragraph 0000). Instead, the Deans method is described as only providing an aggregate indication as to how much fluid has been recovers [sic] regardless of which location in the well that fluid has resided (Declaration of Gary Wooley, Paragraph 17(a)). Indeed, Deans has no disclosure or suggestion that it can be used to verify differential mobility in a well (Declaration of Gary Wooley, Paragraph 17(a)).

Patent Owner's arguments are not persuasive for the same reasons as stated above in section 2C with respect to **Hinkel** and **Deans.**

3. Rejection Based on Hinkel in View of Hall

Patent Owner argues the following (page 21 of the response filed on 9/16/2013):

> As discussed above, the intended purpose of the tracer study in Hinkel is to determine whether or not the fluid in the distal end of a fracture is the first fluid that is recovered. However, the tracer method of Hall is only used to determine how long a fluid has resided in a well (Declaration of Gary Wooley, Paragraph 17(i)). The Hall method is not described as being capable of making a distinction as to which fluid from a particular region in a well is the first to be recovered from a well (Declaration of Gary Wooley, Paragraph 17(i)). Instead, the Hall method is described as only providing information regarding mud circulation (Declaration of Gary Wooley, Paragraph 17(i)). Hall has no disclosure or suggestion that it can be used to verify differential mobility of fluids in a well (Declaration of Gary Wooley, Paragraph 17(i)).
>
> The only reason that Hinkel proposes a tracer study is to verify the differential mobility fracturing technique. Hall is unsatisfactory for such a use. Because the Hall tracer method is "unsatisfactory for its intended purpose" of verifying differential mobility, there is no suggestion or motivation to make the proposed modification. Accordingly, the Hinkel and Hall combination cannot be the basis of a prima facie case of obviousness of the present claims.

Patent Owner's arguments are not persuasive for the same reasons as stated above in section 2C with respect to **Hall**.

4. Secondary Consideration

A. Patent Owner argues that "it appears that the Examiner is requiring that a nexus be established between the pending claims and the commercial service strictly with the commercial brochure. As the Examiner is no doubt aware, there is no requirement that brochures for "SERVICES" be marked with patent numbers. The purpose of the brochure is not to instruct the public on how to perform the claimed invention but rather to market the services which are within the scope of the claims." (Pages 36-37 of the response filed on 9/16/2013).

Patent Owner appears to acknowledge that the nexus between the pending claims and the commercial service cannot be established based on the commercial brochure. In the previous response filed on 1/22/2013, Patent Owner relied on the commercial brochure filed with Mr. Hampton's declaration as evidence to show that a nexus exists between the pending claims and its commercial service. Patent Owner stated that Mr. Hampton (in his declaration) demonstrated a correlation (nexus) between the elements of the combination of original patented claims 1 and 8 and the commercial process known as SPECTRAGHEM® as evidenced by the brochure (see pages 20-22 of the response filed on 1/22/2013). Patent Owner now argues that the purpose of the brochure is not to instruct the public on how to perform the claimed invention but rather to market the services which are within the scope of the claims.

However, as stated in the ACP filed on 8/16/2013 (page 39-41), the brochure alone does not support that the SPECTRAGHEM® services are within the scope of the claims.

Further, Patent Owner cites the Supplemental Declaration of Mr. Hampton and argues the following:

> Turing specifically to the Supplemental Declaration of Mr. Hampton, each of the Examiner's objections as recited in the ACP were addressed. Patent Owner states that "[a]t paragraph 17, Mr. Hampton affirmatively states that the tracers are admixed with the fracturing materials. At paragraph 18, Mr. Hampton affirmatively states that flowback samples are analyzed for the concentration of the tracer present in the production fluid. Please note that as further proof of this issue, a flowback report is being filed herewith and is discussed at paragraph 19. Mr. Hampton affirmatively states that a calculation is performed with each job and this is discussed at paragraph 20.

However, the additional evidence submitted with the Supplemental Declaration of Mr. Hampton is still insufficient to show a nexus between the claimed invention and the commercial service.

At paragraphs 17-19 of the Supplemental Declaration, Mr. Hampton states that ProTechnics performs the admixing step at the oil well. ProTechnics injects the tracer into the flow of the hydraulic fracture fluid as it is being pumped down the well at a predetermined rate. The flowback samples are analyzed for the concentration of the tracer present in the production fluid. However, the flowback report referred by Mr. Hampton as evidence does not show that the amount of the admixture recovered is <u>calculated</u> using the concentration of the tracer present in the production fluid as a basis as recited in the claims of the '662 patent.

At paragraph 20 of the Supplemental Declaration, Mr. Hampton states:

> The SpectraChem™ brochure states that "SPECTRACHEM tracers are routinely used to quantify and profile frac fluid clean-up and flowback efficiency over time." See Exhibit B. During the preliminary injunction hearing, I explained that ProTechnics performs this step by either using a mass balance approach or a relative rate of recovery approach. See Exhibit A, page 28, line 1, to page 32, line 5. Using the example flowback report, I explained that the graph on page 4 of the report showed the concentration of each tracer over time. See id.; see also Exhibit C. I explained that for stages one and two of this well, the tracer concentration was zero, indicating that there was no flowback from these two stages of the well. This information allowed the well operator to determine that there was an obstruction in the wellbore, and helped to pinpoint the location of the obstruction. See id., page 28, lines 14-25. I also explained that the tracer concentrations were used to determine the amounts of fluid that were flowing back. See id., page 29, line 1, to page 32, line 6.

Mr. Hampton relies on the commercial brochure and the flowback report as evidence to show that the calculation step in the commercial service is performed. However, both the commercial brochure and the flowback report do not show that the amount of the admixture recovered is <u>calculated</u> using the concentration of the tracer present in the production fluid as a basis.

B. Patent Owner also cites a declaration of Mr. Mike Flecker and the Supplemental Declaration of Mr. Hampton and argues the following (pages 39-40 of the response filed on 9/16/2013):

> Mr. Flecker testifies that since its introduction, the invention has captured 100% of the market except during periods of patent infringement. Also included in Mr. Flecker's declaration is a graph showing the rate of growth of revenues from the sale of the SpectraChem Services as a function of time. It is important to note that even with the downturn in the economy and price erosion caused by the Requester, the Patent Owner's revenues associated with the sales of the patented services have continued to climb at a dramatic rate.
>
> Turning to the Examiner's complaint that the Patent Owner has not shown that any commercial success of the SpectraChem is not the result of other factors such as the result of heavy promotion/advertising or consumption by purchasers

> normally tied to the Patent Owner; the Patent Owner provides evidence in the form of Mr. Hampton's supplemental declaration stating that the Patent Owner's marketing costs are less than 0.1% of revenues. Also disclosed therein is an affirmative assertion by the Patent Owner that the purchasers of the SpectraChem services are oil and gas production and exploration companies that are not related to or affiliated with the Patent Owner.

Patent Owner's arguments are not persuasive for the same reasons as stated on pages 42-44 of the ACP filed 8/16/2013. Specifically, an affidavit or declaration attributing commercial success to a product or process "constructed according to the disclosure and claims of [the] patent application" or other equivalent language does not establish a nexus between the claimed invention and the commercial success because there is no evidence that the product or process which has been sold corresponds to the claimed invention, or that whatever commercial success may have occurred is attributable to the product or process defined by the claims. *Ex parte Standish*, 10 USPQ2d 1454, 1458 (Bd. Pat. App. & Inter. 1988). Also, MPEP 716.03(a).

Further, as also argued by Requester (pages 32-33 of the comments filed on 10/7/2013):

> In Requester's Comments filed on February 20, 2013, Requester showed that the Patent Owner's alleged sales over an 11 1/2 year period from July 2001 were neither surprising, unusual, nor out of the ordinary in comparison to the size of the Patent Owner's business and the market share which it enjoys. The Patent Owner is one of the world's leading providers of reservoir services to the oil and gas industry, with 70 offices in more than 50 countries and approximately 5000 employees. The Patent Owner's total revenues for the period extending from 2001 through 2012 were over $6,416 million. Consequently, a total sales number of $100 million for the patented method for the years 2001-2012 would amount to only 1.56% of the Patent Owner's total revenues over the same period.
>
> Moreover, even if "commercial success" had been shown by the Patent Owner, "[m]erely showing that there was commercial success of an article which embodied the invention is not sufficient." MPEP § 716.03 (b) (I). "To be pertinent to the issue of nonobviousness, the commercial success of devices falling within

> the claims of the patent must flow from the functions and advantages disclosed or inherent in the description in the specification." MPEP §716.03 (b) (II). "[C]onclusory statements or opinions that increased sales were due to the merits of the invention are entitled to little weight." Id.

Requester also notes the following (pages 33-34 of the comments filed on 10/7/2013):

> Although the Patent Owner, not the Requester STS, bears the burden of proof on the Patent Owner's claim of commercial success, Requester presented significant evidence in its earlier Comments filed on February 20, 2013 that:
>
> - Concerning its revenues over the years in question, the Patent Owner's Annual Report for 2011 credits typical market forces in the oil and gas industry.
>
> - Not only have the sales of the Patent Owner's ProTechnics division simply tracked the obvious market factors identified in the annual reports, but ProTechnics' sales of these types of services, though they have generally increased in correspondence with these obvious market factors over the period in question, have actually lagged behind the increase in the use of fracturing operations and the related completion of horizontal wells industry-wide.
>
> - While ProTechnics' sales increased from $25 million in 2003 to $118 million in 2012, fracturing activity, as indicated by frac horsepower, increased from 2.063 million horsepower in 2003 to 17.991 million horsepower in 2012 and the number of horizontal well completions increased from 1,400 in 2003 to 17,700 in 2012. Thus, while the level of fracturing activity in 2012 was 8.7 times the level of activity in 2003 and the number of horizontal completions in 2012 was 12.6 times the number in 2003, ProTechnics sales in 2012 were only 4.7 times its sales in 2003.
>
> - Consequently, contrary to its claim of commercial success, ProTechnics' sales have not actually even kept pace with fracturing activities and expenditures in the industry overall.
>
> - ProTechnics' sales from 2003 to the present predictably followed the obvious market factors such as the price of oil, fracturing activity, and the number of horizontal well completions.

C. Patent Owner also cites the Supplemental Declaration of Hampton and argues that (page 41 of the response filed on 9/16/2013):

> [t]he Examiner's attention is directed to Mr. Hampton's supplemental declaration at paragraph 22. Therein it is disclosed that the "solution" provided by the SPE 31094 reference does not indeed solve the long felt need disclosed therein. For example it does not provide any way to differentiate one fracture zone or stage from another.

Patent Owner's arguments are not commensurate with the scope of the claims. The claims of the ‘662 patent do not require any method step “to differentiate one fracture zone or stage from another.” The ‘662 patent also does not describe that there is a long felt need of providing a way “to differentiate one fracture zone or stage from another.”

Further, as also argued by Requester (page 29 of the comments filed on 10/7/2013):

> SPE 31094 does not even mention fracture zones or stages and never states that a need exists for a way to differentiate one fracture zone for another. Consequently, SPE 31094 provides absolutely no objective evidence of the existence of the new "need" which the Patent Owner wishes to create.

D. With respect to the secondary consideration of praise by other and copying by others (pages 42-43 of the response filed on 9/16/2013), Patent Owner maintains the same arguments as presented in the response filed on 1/22/2013. Patent Owner's arguments are not persuasive for the same reasons as set forth at pages 41-42 of the ACP filed on 8/16/2013.

E. Patent Owner also cites *In re Leo Pharmaceutical Products, Ltd.*, 2013 U.S. App. Lexis 16610 and argued that the evidence of commercial success of the invention as claimed is clear and convincing (page 40 of the response filed on 9/16/2013) and that "[t]he Examiner's argument that the claims as amended are obvious is far from strong. This is shown by the number of references to which the Examiner was forced to resort; and the age of many of the Examiner's references. Hinkel issued in 2001 but was filed in 1998. Dugstad was published in 1999. Hall was filed in 1988. Hoots was filed in 1987. And the other references are all older, some going back as far as 1962" (pages 44-45 of the response filed on 9/16/2013).

Patent Owner's arguments are not persuasive. As argued by Requester (pages 24-26 of the comments filed on 10/7/2013):

> The patent claims in Leo Pharmaceutical were for a topical skin treatment composition for psoriasis which was "storage stable." The objective "secondary" indicia of non-obvious presented by Leo consisted, first of all, of a very strong and thorough showing of unexpected results based not only upon several articles which discouraged the combination of components called for in the claims, but also upon "extensive experimental evidence."
>
> Through its experimental tests, which required months to perform, Leo was able to determine and prove that none of the closest prior art compositions were storage stable. Moreover, although the prior art compositions had been known for decades, there was no evidence that, prior to Leo's findings, which took months to discover, the industry had even been aware that the prior art compositions were not storage stable. Consequently, concerning the combination of prior art references which had been cited against the patent claims, there was actually no reason or incentive known to those in the art to apply the teachings of the secondary references to the prior art compositions.
>
> The strong showing of unexpected results was also further supported and confirmed by significant related evidence of commercial success and evidence of long felt but unresolved need. As evidence of commercial success supporting the finding of unexpected results, Leo's product covered by the patent claims

became the first FDA-approved drug to combine vitamin D and corticosteroids into a single formula for topical application. As stated by the Court:

> While FDA approval is not determinative of nonobviousness, it can be relevant in evaluating the objective indicia of nonobviousness. *** Here, FDA approval highlights that Leo Pharmaceutical's formulation is truly storage stable, something that the prior art formulations did not achieve. Leo Pharmaceutical at 33 (citations omitted).

As further confirmation of the unexpected result obtained by Leo, the record also showed that researchers were aware of the benefits of using vitamin D and corticosteroids in the treatment of psoriasis as early as 1986. However, it was not until 2000 that Leo's combined treatment was created.

The convincing proof of unexpected results presented by Leo supported by FDA approval of the composition satisfying a long felt need is in stark contrast to Patent Owner's failure to prove any objective "secondary" indicia of non-obvious.

With respect to the argument relating to the number of references cited, “reliance on a large number of references in a rejection does not, without more, weigh against the obviousness of the claimed invention.” See *In re Gorman*, 933 F.2d 982, 18 USPQ2d 1885 (Fed. Cir. 1991).

In response to Patent Owner's argument based upon the age of the references, “contentions that the reference patents are old are not impressive absent a showing that the art tried and failed to solve the same problem notwithstanding its presumed knowledge of the references.” See *In re Wright*, 569 F.2d 1124, 193 USPQ 332 (CCPA 1977).

Conclusion

The patent owner is reminded of the continuing responsibility under 37 CFR 1.565(a) to apprise the Office of any litigation activity, or other prior or concurrent

proceeding, involving Patent No. 7,032,662 throughout the course of this reexamination proceeding. The third party Requester is also reminded of the ability to similarly apprise the Office of any such activity or proceeding throughout the course of this reexamination proceeding.

This is a RIGHT OF APPEAL NOTICE (RAN); see MPEP § 2673.02 and § 2674. The decision in this Office action as to the patentability or unpatentability of any original patent claim, any proposed amended claim and any new claim in this proceeding is a FINAL DECISION.

No amendment can be made in response to the Right of Appeal Notice in an inter partes reexamination. 37 CFR 1.953(c). Further, no affidavit or other evidence can be submitted in an inter partes reexamination proceeding after the right of appeal notice, except as provided in 37 CFR 1.981 or as permitted by 37 CFR41.77(b)(1). 37 CFR 1.116(f).

Each party has **a thirty-day or one-month time period, whichever is longer**, to file a notice of appeal. The patent owner may appeal to the Patent Trial and Appeal Board with respect to any decision adverse to the patentability of any original or proposed amended or new claim of the patent by filing a notice of appeal and paying the fee set forth in 37 CFR 41.20(b)(1). The third party requester may appeal to the Patent Trial and Appeal Board with respect to any decision favorable to the patentability of any original or proposed amended or new claim of the patent by filing a notice of appeal and paying the fee set forth in 37 CFR 41.20(b)(1).

In addition, a patent owner who has not filed a notice of appeal may file a notice of cross appeal within **fourteen days of service** of a third party requester's timely filed notice of appeal and pay the fee set forth in 37 CFR 41.20(b)(1). A third party requester who has not filed a notice of appeal may file **a notice of cross appeal within fourteen days of service** of a patent owner's timely filed notice of appeal and pay the fee set forth in 37 CFR 41.20(b)(1).

Any appeal in this proceeding must identify the claim(s) appealed, and must be signed by the patent owner (for a patent owner appeal) or the third party requester (for a third party requester appeal), or their duly authorized attorney or agent.

Any party that does not file a timely notice of appeal or a timely notice of cross appeal will lose the right to appeal from any decision adverse to that party, but will not lose the right to file a respondent brief and fee where it is appropriate for that party to do so. If no party files a timely appeal, the reexamination prosecution will be terminated, and the Director will proceed to issue and publish a certificate under 37 CFR 1.997 in accordance with this Office action.

All correspondence relating to this *inter partes* reexamination proceeding should be directed:

By EFS: Registered users may submit via the electronic filing system EFS-Web at
https://efs.uspto.gov/efile/myportal/efs-registered

Please mail any communications to:
Attn: Mail Stop "Inter Partes Reexam"
Central Reexamination Unit
Commissioner for Patents
P. O. Box 1450
Alexandria VA 22313-1450

Please hand-deliver any communications to:
Customer Service Window
Attn: Central Reexamination Unit
Randolph Building, Lobby Level
401 Dulany Street
Alexandria, VA 22314

Please FAX any communications to:
(571) 273-9900
Central Reexamination Unit

Signed:

/Ling Xu/
Patent Reexamination Specialist
Central Reexamination Unit 3991

Conferees:

/Alan Diamond/
Patent Reexamination Specialist
Central Reexamination Unit 3991

/Deborah D Jones/
Supervisory Patent Examiner, Art Unit 3991

Index of Claims	Application/Control No. 95002144	Applicant(s)/Patent Under Reexamination 7,032,662
	Examiner LING XU	Art Unit 3991

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	10/22/2012	08/01/2013	02/04/2014						
	1	✓	✓	✓						
	2	✓	✓	✓						
	3	✓	✓	✓						
	4	✓	✓	✓						
	5	✓	✓	✓						
	6	✓	✓	✓						
	7	✓	✓	✓						
	8	✓	-	-						
	9	✓	✓	✓						
	10	✓	✓	✓						
	11	N	N	N						
	12	N	N	N						
	13	✓	✓	✓						
	14	✓	✓	✓						
	15	✓	✓	✓						
	16	✓	✓	✓						
	17	✓	✓	✓						
	18	✓	✓	✓						
	19	✓	✓	✓						
	20	✓	✓	✓						
	21	✓	✓	✓						

UNITED STATES COURT OF APPEALS
FOR THE FEDERAL CIRCUIT

CORE LABORATORIES LP,
Owner/Appellant

v.

SPECTRUM TRACER SERVICES, LLC,
Requester/Appellee

Re-Exam Control No: 95/002,141

NOTICE FORWARDING CERTIFIED LIST

A Notice of Appeal to the United States Court of Appeals for the Federal Circuit was timely filed on May 22, 2015, in the United States Patent and Trademark Office in connection with the above identified *inter partes* re-examination proceeding. Pursuant to 35 U.S.C. § 143, and Fed. Cir. R. 17(b)(1), a Certified List is this day being forwarded to the Federal Circuit.

Respectfully submitted,

By: Macia L. Fletcher
Macia L. Fletcher
Paralegal
Mail Stop 8
P.O. Box 1450
Alexandria, VA 22313-1450
571-272-9035

Under Secretary of Commerce for
Intellectual Property and Director of the
United States Patent and Trademark Office

Date: July 1, 2015

CERTIFICATE OF SERVICE

The undersigned hereby certifies that a true and correct copy of the foregoing has been served on Appellant and Appellee this 1st day of July, 2015, as follows:

Patent Owner:

Tawni L. Wilhelm
SHOOK, HARDY & BACON L.L.P.
2555 Grand Boulevard
Kansas City, MO 64108

Third Party Requester:

Dennis D. Brown
Brown Patent Law P.L.L.C.
2700 N. Hemlock Ct., Suite 111 E
Broken Arrow, OK 74012

By: Macia L. Fletcher
Macia L. Fletcher
Paralegal
Mail Stop 8
P.O. Box 1450
Alexandria, VA 22313-1450
571-272-9035

Form PTO 55 (12-80)

U.S. DEPARTMENT OF COMMERCE
United States Patent and Trademark Office

July 1, 2015
(Date)

THIS IS TO CERTIFY that the attached document is a list of the papers that comprise the record before the Patent Trial and Appeal Board (PTAB) for the *Inter Partes Reexamination* proceeding identified below:

SPECTRUM TRACER SERVICES, LLC.,
Third Party Requester

v.

CORE LABORATORIES LP,
Patent Owner

Appeal 2015-000198
Reexamination Control No. 95/002,141
Patent 6,659,175 B2

By authority of the

DIRECTOR OF THE UNITED STATES
PATENT AND TRADEMARK OFFICE

Tracia L. Fletcher
Certifying Officer

Prosecution History Proceeding 95/002,141

Date	Document
09/06/2012	REQUEST FOR INTER PARTES REEXAMINATION
09/06/2012	INFORMATION DISCLOSURE STATEMENT
09/10/2012	TITLE REPORT
09/13/2012	NOTICE OF REEXAMINATION REQUEST FILING DATE
09/11/2012	NOTICE OF ASSIGNMENT OF INTER PARTES REEXAMINATION REQUEST
11/19/2012	ORDER GRANTING REQUEST FOR INTER PARTES REEXAMINATION
11/19/2012	NON-FINAL OFFICE ACTION
11/26/2012	CORRESPONDENCE ADDRESS CHANGE
12/04/2012	NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY
12/04/2012	NOTICE REGARDING CHANGE OF POWER OF ATORNEY
01/22/2013	RESPONSE AFTER NON-FINAL OFFICE ACTION
01/22/2013	PETITION TO EXPUNGE INFORMATION
01/31/2013	THIRD PARTY REQUESTER'S CORRESPONDENCE ADDRESS CHANGE
02/19/2013	PETITION DECISION - DENIED
02/20/2013	THIRD PARTY REQUESTER'S COMMENTS TO PATENT OWNER'S RESPONSE TO NON-FINAL OFFICE ACTION
08/16/2013	ACTION CLOSING PROSECUTION
09/16/2013	PATENT OWNER'S COMMENTS TO ACTION CLOSING PROSECUTION
10/07/2013	THIRD PARTY REQUESTER'S COMMENTS TO PATENT OWNER'S COMMENTS TO ACTION CLOSING PROSECUTION
02/07/2014	RIGHT OF APPEAL NOTICE
03/07/2014	NOTICE OF APPEAL
05/07/2014	APPEAL BRIEF
05/13/2014	NOTICE OF DEFECTIVE APPEAL BRIEF
05/23/2014	REPLY BRIEF
06/13/2014	RESPONSE TO NOTICE OF DEFECTIVE APPEAL BRIEF
07/21/2014	EXAMINERS ANSWER
08/18/2014	REBUTTAL BRIEF
08/18/2014	PATENT OWNER'S REQUEST FOR ORAL HEARING
09/05/2014	REBUTTAL BRIEF NOTED
10/07/2014	BOARD DOCKETING NOTICE
12/15/2014	NOTICE OF HEARING
12/16/2014	THIRD PARTY REQUESTER'S CORRESPONDENCE ADDRESS CHANGE
12/29/2014	THIRD PARTY REQUESTER'S REQUEST FOR ORAL HEARING

Prosecution History Proceeding 95/002,141

Date	Document
12/29/2014	THIRD PARTY REQUESTER'S CONFIRMATION OF HEARING
12/30/2014	APPELLANT'S CONFIRMATION OF HEARING
01/29/2015	THIRD PARTY REQUESTER'S REQUEST FOR EQUIPMENT FOR DEMONSTRATIVES FOR ORAL HEARING
03/12/2015	ORAL HEARING TRANSCRIPT
03/24/2015	PTAB DECISION ON APPEAL

UNITED STATES COURT OF APPEALS
FOR THE FEDERAL CIRCUIT

CORE LABORATORIES LP,
Owner/Appellant

v.

SPECTRUM TRACER SERVICES, LLC,
Requester/Appellee

Re-Exam Control No: 95/002,144

NOTICE FORWARDING CERTIFIED LIST

A Notice of Appeal to the United States Court of Appeals for the Federal Circuit was timely filed on May 22, 2015, in the United States Patent and Trademark Office in connection with the above identified *inter partes* re-examination proceeding. Pursuant to 35 U.S.C. § 143, and Fed. Cir. R. 17(b)(1), a Certified List is this day being forwarded to the Federal Circuit.

Respectfully submitted,

By: Macia L. Fletcher
Macia L. Fletcher
Paralegal
Mail Stop 8
P.O. Box 1450
Alexandria, VA 22313-1450
571-272-9035

Under Secretary of Commerce for
Intellectual Property and Director of the
United States Patent and Trademark Office

Date: July 1, 2015

CERTIFICATE OF SERVICE

The undersigned hereby certifies that a true and correct copy of the foregoing has been served on Appellant and Appellee this 1st day of July, 2015, as follows:

Patent Owner:

Tawni L. Wilhelm
SHOOK, HARDY & BACON L.L.P.
2555 Grand Boulevard
Kansas City, MO 64108

Third Party Requester:

Dennis D. Brown
Brown Patent Law P.L.L.C.
2700 N. Hemlock Ct., Suite 111 E
Broken Arrow, OK 74012

By: Macia L. Fletcher
Macia L. Fletcher
Paralegal
Mail Stop 8
P.O. Box 1450
Alexandria, VA 22313-1450
571-272-9035

Form PTO 55 (12-80)

U.S. DEPARTMENT OF COMMERCE
United States Patent and Trademark Office

July 1, 2015
(Date)

THIS IS TO CERTIFY that the attached document is a list of the papers that comprise the record before the Patent Trial and Appeal Board (PTAB) for the *Inter Partes Reexamination* proceeding identified below:

SPECTRUM TRACER SERVICES, LLC.,
Third Party Requester

v.

CORE LABORATORIES LP,
Patent Owner

Appeal 2015-001257
Reexamination Control No. 95/002,144
Patent 7,032,662 B2

By authority of the

DIRECTOR OF THE UNITED STATES
PATENT AND TRADEMARK OFFICE

Macia L. Fletcher
Certifying Officer

Prosecution History Proceeding 95/002,144

Date	Document
09/06/2012	REQUEST FOR INTER PARTES REEXAMINIATION
09/06/2012	INFORMATION DISCLOSURE STATEMENT FILED
09/13/2012	TITLE REPORT
09/17/2012	NOTICE OF ASSIGNMENT OF REEXAMINATION REQUEST
09/17/2012	NOTICE OF REEXAMINATION REQUEST FILING DATE
11/19/2012	ORDER GRANTING REQUEST FOR INTER PARTES REEXAMINATION
11/19/2012	NON-FINAL OFFICE ACTION
11/26/2012	CORRESPONDENCE ADDRESS CHANGE
12/04/2012	NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY
12/04/2012	NOTICE REGARDING CHANGE OF POWER OF ATTORNEY
01/22/2013	RESPONSE TO NON-FINAL OFFICE ACTION
01/22/2013	PETITION TO EXPUNGE INFORMATION
01/31/2013	THIRD PARTY REQUESTER'S CORRESPONDENCE ADDRESS CHANGE
02/19/2013	PETITION DECISION - DENIED
02/20/2013	THIRD PARTY REQUESTER'S COMMENTS COMMENTS TO PATENT OWNER'S RESPONSE TO NON-FINAL OFFICE ACTION
08/16/2013	ACTION CLOSING PROSECUTION
09/16/2013	PATENT OWNER COMMENTS TO ACTION CLOSING PROSECUTION
10/07/2013	THIRD PARTY REQUESTER'S COMMENTS TO PATENT OWNER'S COMMENTS TO ACTION CLOSING PROSECUTION
02/07/2014	RIGHT OF APPEAL NOTICE
03/07/2014	NOTICE OF APPEAL
05/07/2014	APPEAL BRIEF
05/16/2014	NOTICE OF DEFECTIVE APPEAL BRIEF
05/23/2014	REPLY BRIEF
06/13/2014	RESPONSE TO NOTICE OF DEFECTIVE APPEAL BRIEF
07/21/2014	EXAMINER'S ANSWER
08/18/2014	REBUTTAL BRIEF
08/18/2014	PATENT OWNER'S REUEST FOR ORAL HEARING
09/05/2014	REBUTTAL BRIEF NOTED
11/18/2014	BOARD DOCKETING NOTICE
12/15/2014	NOTICE OF HEARING
12/29/2014	THIRD PARTY REQUESTER'S REQUEST FOR ORAL HEARING
12/29/2014	THIRD PARTY REQUESTER'S CONFORMATION OF HEARING

Prosecution History Proceeding 95/002,144

Date	Document
12/30/2014	APPELLANT'S CONFIRMATION OF HEARING
01/29/2015	THIRD PARTY REQUESTER'S REQUEST FOR EQUIPMENT FOR DEMONSTRATIVES FOR ORAL HEARING
03/12/2015	ORAL HEARING TRANSCRIPT
03/24/2015	PTAB DECISION ON APPEAL

US006659175B2

(12) **United States Patent**
Malone et al.

(10) **Patent No.: US 6,659,175 B2**
(45) **Date of Patent: Dec. 9, 2003**

(54) **METHOD FOR DETERMINING THE EXTENT OF RECOVERY OF MATERIALS INJECTED INTO OIL WELLS DURING OIL AND GAS EXPLORATION AND PRODUCTION**

(75) Inventors: **Scott Malone**, Highlands Ranch, CO (US); **Earuch Broacha**, Farmington, NM (US); **Don Shaw**, Denver, CO (US); **Tom Hampton**, Houston, TX (US)

(73) Assignee: **Core Laboratories, Inc.**, Houston, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/154,130**

(22) Filed: **May 23, 2002**

(65) **Prior Publication Data**

US 2003/0006036 A1 Jan. 9, 2003

Related U.S. Application Data

(60) Provisional application No. 60/293,071, filed on May 23, 2001.

(51) **Int. Cl.**[7] **E21B 43/267**; E21B 47/00; G01N 33/24

(52) **U.S. Cl.** **166/250.1**; 166/250.12; 166/280; 73/152.42; 175/42; 436/27; 436/29; 507/267; 507/907; 507/924

(58) **Field of Search** 166/250.1, 250.12, 166/252.6, 280, 308; 73/152.42; 175/40, 42; 250/259, 260; 436/27, 28, 29; 507/267, 906, 907, 922, 924

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,207,348 A	*	7/1940	Jones et al.	436/29
2,869,642 A	*	1/1959	McKay et al.	166/250.01
3,059,909 A		10/1962	Wise	261/39
3,180,142 A	*	4/1965	Bombardieri	73/152.18
3,301,723 A		1/1967	Chrisp	149/20
3,316,965 A	*	5/1967	Watanabe	166/280
3,492,147 A	*	1/1970	Young et al.	427/5
3,856,468 A	*	12/1974	Keller	436/27
3,888,312 A		6/1975	Tiner et al.	166/308
4,273,187 A		6/1981	Satter et al.	166/250
4,352,674 A	*	10/1982	Fery	436/27
4,373,586 A		2/1983	Hunt, III	166/263
4,415,805 A	*	11/1983	Fertl et al.	250/260
4,681,245 A		7/1987	Harvey	222/643
4,807,469 A	*	2/1989	Hall	73/152.19
4,840,292 A		6/1989	Harvey	222/1
5,049,743 A	*	9/1991	Taylor et al.	250/303
5,077,471 A		12/1991	Smith, Jr. et al.	250/260
5,246,860 A	*	9/1993	Hutchins et al.	436/27
5,279,967 A		1/1994	Bode	436/56
5,410,152 A		4/1995	Gadeken	250/260
5,929,437 A	*	7/1999	Elliott et al.	250/259
5,986,030 A		11/1999	Murray et al.	526/268
6,003,365 A	*	12/1999	Pope et al.	73/152.39
6,016,191 A		1/2000	Ramos et al.	356/70
6,025,200 A	*	2/2000	Kaish et al.	436/56
6,075,611 A		6/2000	Dussan et al.	356/432
6,076,046 A		6/2000	Vasudevan et al.	702/12
6,125,934 A		10/2000	Lenn et al.	166/250.12
6,148,913 A		11/2000	Collins	166/263
6,192,985 B1	*	2/2001	Hinkel et al.	166/280

OTHER PUBLICATIONS

Alcohols, http://www.egi.utah.edu/geothermal/Tracer/T_Studies/,Mar. 3, 1998.

Michael C. Adams et al.; *The Application of Halogenated Alkanes as Vapor–Phase Tracers: A Field Test in the Southeast Geysers*, http://www.egi.utah.edu/geothermal/Tracer/T_Studies/, Mar. 3, 1998, 9 pgs.

Joseph J. Beall et al.; *R–13 Tracing of Injection in the Geysers*, http://www.egi.utah.edu/geothermal/Tracer/T_Studies/, Mar. 3, 1998, pp. 1–11.

Michael C. Adams et al., *Rhodamine WT as a Geothermal Tracer—A Field Test at Steamboat Hills, Nevada*, http://www.egi.utah.edu/geothermal/Tracer/T_Studies/, Mar. 3, 1998, 13 pgs.

Michael C. Adams et al.; *Thermal Stabilities of Aromatic Acids as Geothermal Tracers*, http://www.egi.utah.edu/geothermal/Tracer/T_Studies/, Sep. 21, 1998, pp. 1–23, 3 pages of references.

Michael C. Adams et al,; *The Dixie Valley, Nevada Tracer Test*, ESL—93011—PR, http://www.egi.utah.edu/geothermal/Tracer/T_Studies/, Mar. 3, 1998, Table of Contents, pp. 1–11, Appendix A, Appendix B.

Michael C. Adams et al.; *Kinetics of Fluorscein Decay and Its Application as a Geothermal Tracer*, http://www.egi.utah.edu/geothermal/Tracer/T_Studies/, Mar. 3, 1998, pp. 1–27.

* cited by examiner

Primary Examiner—George Suchfield
(74) *Attorney, Agent, or Firm*—Madan, Mossman & Sriram, P.C.

(57) **ABSTRACT**

Disclosed is a method of determining the extent of recovery of materials injected into a oil well comprising the steps of: a) preparing a material to be injected into an oil well; b) admixing therewith a chemical tracer compound at a predetermined concentration; c) injecting the admixture into an oil well; d) recovering from the oil well a production fluid; e) analyzing the production fluid for the concentration of the chemical tracer present in the production fluid; and f) calculating the amount of admixture recovered from the oil well using the concentration of the chemical tracer present in the production fluid as a basis for the calculation. Fluorinated benzoic acids are disclosed as a preferred tracer.

11 Claims, No Drawings

METHOD FOR DETERMINING THE EXTENT OF RECOVERY OF MATERIALS INJECTED INTO OIL WELLS DURING OIL AND GAS EXPLORATION AND PRODUCTION

RELATED APPLICATIONS

This application claim priority from U.S. Provisional Patent Application Ser. No. 60/293,071 filed on May 23, 2001.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method for determining the extent of recovery of materials injected into an oil well during oil and gas exploration and production. The present invention particularly relates to a method for determining the extent of recovery of materials injected into an oil well during oil and gas exploration and production using chemical tracers.

2. Background of the Art

The present Invention relates generally to hydrocarbon (oil and gas) production from wells drilled in the earth, hereinafter referred to as "oil wells." Drilling a hole into the earth to reach oil and gas bearing formations is expensive which limits the number of wells that can be economically drilled. It follows then that it is desirable to maximize both and the overall recovery of hydrocarbon held in the formation and the rate of flow from the subsurface formation to the surface, where it can be recovered.

One way in which to maximize production is the process known as fracturing. Hydraulic fracturing involves literally breaking or fracturing a portion of the hydrocarbon bearing formation surrounding an oil well by injecting a specialized fluid into the wellbore directed at the face of the geologic formation at pressures sufficient to initiate and/or extend a fracture in the formation. Ideally, what this process creates is not a single fracture, but a fracture zone, i.e., a zone having multiple fractures, or cracks in the formation, through which hydrocarbon can more readily flow to the wellbore.

Creating a fracture in a hydrocarbon-bearing formation requires several materials. Often these materials, if not removed from the oil well, can interfere with oil and gas production. Even the drilling mud used to lubricate a drill bit during the drilling of an oil well can interfere with oil and gas production. Taking too long to remove such materials can increase the cost to the operator of the well by delaying production and causing excess removal expenses. Not being thorough in removing such materials can increase the cost to the operator of the well through lower production rates and possible lost production.

Measures taken to remove unwanted or unneeded materials are usually inexact. Sometimes additional fluids are used to flush out unwanted materials in the well bore. In other situations, reservoir fluids flow can make estimating return flow very difficult, particularly if the reservoir fluids are incompatible with the injected materials. It would be desirable in the art of oil and gas production to be able to determine how much of a given material is left in an oil well after a drilling, fracturing or any other operation requiring the injection of materials into an oil well. It would be particularly desirable if such a determination could be made using an inexpensive and environmentally benign method.

SUMMARY OF THE INVENTION

In one aspect, the present invention is a method for determining the extent of recovery of materials injected into a oil well comprising the steps of: a) preparing a material to be injected into an oil well; b) admixing therewith a chemical tracer compound at a predetermined concentration; c) injecting the admixture into an oil well; d) recovering from the oil well a production fluid; e) analyzing the production fluid for the concentration of the chemical tracer present in the production fluid; and f) calculating the amount of admixture recovered from the oil well using the concentration of the chemical tracer present in the production fluid as a basis for the calculation.

DESCRIPTION OF PREFERRED EMBODIMENTS

As already defined, the term "oil well" means hydrocarbon (oil and gas) production wells drilled in the earth. The method of the present invention can also be used with other types of wells that are drilled in the earth and can require stimulation by hydraulic fracturing, such as a well used for water flooding in secondary recovery operations in oil and gas production. For the purposes of the present invention, the term "oil well" means hydrocarbon production wells, but also any other type of well that can require stimulation by hydraulic fracturing.

In one embodiment, the present invention is a method for determining the amount of fracture materials recovered after the stimulation of an oil well by means of hydraulic fracturing. Creating a fracture in a hydrocarbon-bearing formation requires several materials. Most often these include a carrier fluid, a viscosifier, a proppant, and a breaker. Other components that are sometimes added include materials to control leak-off, or migration of the fluid into the fracture face, gel stabilizers, surfactants, clay control agents and crosslinkers.

The purpose of the first fracturing component is to first create/extend a fracture in an oil and gas producing formation and then, once it is opened enough, to deliver proppant. The carrier fluid together with proppant material is injected into the fractured formation. The carrier fluid is simply the means by which the proppant and breaker are carried into the formation.

Numerous substances can act as a suitable carrier fluid, though they are generally aqueous-based solutions that have been either gelled or foamed or both. Thus, the carrier fluid is often prepared by blending a polymeric gelling agent with an aqueous solution although sometimes the carrier fluid is oil-based or a multi-phase fluid. Often, the polymeric gelling agent is a solvatable polysaccharide, e.g., galactomannan gums, glycomannan gums, and cellulose derivatives. The purpose of the solvatable or hydratable polysaccharides is to thicken the aqueous solution so proppant can be suspended in the solution for delivery into the fracture.

The polysaccharides function as viscosifiers, increasing the viscosity of the aqueous solution by 10 to 100 times, or even more. During high temperature applications, a cross-linking agent is further added which further increases the viscosity of the solution. The borate ion has been used extensively as a crosslinking agent for hydrated guar gums and other galactomannans to form aqueous gels, e.g., U.S. Pat. No. 3,059,909. Other demonstrably suitable cross-linking agents include: titanium as disclosed in U.S. Pat. No. 3,888,312, chromium, iron, aluminum, and zirconium as disclosed in U.S. Pat. No. 3,301,723. More recently, viscoelastic surfactants have been developed which obviates the need for thickening agents, and hence cross-linking agents.

Most relevant to the present invention is the final step of the fracturing process. The process of removing the fluid

from the fracture once the proppant has been delivered is referred to as "fracture clean-up." For this, the final component of the fracture fluid becomes relevant: the breaker. The purpose of the breaker is to lower the viscosity of the fluid so that it is more easily removed from the fracture.

In another aspect, the present invention is a method for determining the amount of drilling fluid recovered after the completion of an oil well. A drilling fluid is a fluid specially designed to be circulated through a wellbore as the wellbore is being drilled to facilitate the drilling operation. The circulation path of the drilling fluid typically extends from the wellhead down through the drill pipe string to the drilling face and back up through the annular space between the drill pipe string and wellbore face to the wellhead. The drilling fluid performs a number of functions as it circulates through the wellbore including cooling and lubricating the drill bit, removing drill cuttings from the wellbore, aiding in support of the drill pipe and drill bit, and providing a hydrostatic head to maintain the integrity of the wellbore walls and prevent well blowouts.

There are a number of different types of conventional drilling fluids including compositions termed "drilling muds." Drilling muds comprise high-density dispersions of fine solids in an aqueous liquid or a hydrocarbon liquid. An exemplary drilling mud is a dispersion of clay and/or gypsum in water. The solid component of such a dispersion is termed a "weighting agent" and is designed to enhance the functional performance of the drilling fluid.

In the practice of the present invention, the extent of recovery of materials injected into a oil well during fracturing, drilling and the like is determined by preparing the fracture materials or drilling fluids to be injected into an oil well and admixing therewith a chemical tracer compound at a predetermined concentration. The tracers useful with the present invention include any known to those ordinary skill in the art of using chemical tracers in oil and gas operations to be useful, but preferably are those which can be detected at concentrations low enough to make their use economically practical in such operations and low enough to interfere with the carrier fluid or other materials present in the oil well. Preferably the chemical tracers useful with the present invention include but are not limited to: fluorinated benzoic acids including 2-fluorobenzoic acid; 3-fluorobenzoic acid; 4-fluorobenzoic acid; 3,5-difluorobenzoic acid; 3,4-difluorobenzoic acid; 2,6-difluorobenzoic acid; 2,5-difluorobenzoic acid; 2,3-difluorobenzoic acid; 2,4-difluorobenzoic acid; pentafluorobenzoic acid; 2,3,4,5-tetrafluorobenzoic acid; 4-(trifluoro-methyl)benzoic acid; 2-(trifluoromethyl)benzoic acid; 3-(trifluoro-methyl)benzoic acid; 3,4,5-trifluorobenzoic acid; 2,4,5-trifluorobenzoic acid; 2,3,4-trifluorobenzoic acid; 2,3,5-trifluorobenzoic acid; 2,3,6-trifluorobenzoic acid; 2,4,6-trifluorobenzoic acid; and the like, perfluoromethylcyclopentane (PMCP), perfluoromethylcyclohexane (PMCH), perfluorodimethylcyclobutane (PDMCB), m-perfluorodimethylcyclohexane (m-PDMCH), o-perfluorodimethylcyclohexane (o-PDMCH), p-Perfluorodimethylcyclohexane (p-PDMCH), perfluorotrimethylcyclohexane (PTMCH), perfluoroethylcyclohexane (PECH), perfluoroisopropylcyclohexane (IPPCH), and the like.

Any chemical compound can be used as tracer with the present invention if it is not present at a measurable level in the reservoir fluids being produced from the well being tested, it can be measured at levels sufficiently low to allow its use to be economical, and the tracer does not interfere or interact undesirably with other materials present in the oil well at the levels used. Preferably, the tracers are detectable at a range of from about 1 parts per trillion to about 10,000 parts per million in the fluid being analyzed. Preferably the tracers are detectable at a range of from 5 parts per trillion to about 1,000 parts per million. More preferably the tracers are detectable at a range of from 100 parts per trillion to about 100 parts per million. At concentrations greater than about 1000 parts per million, the use of some tracers can become prohibitively expensive or cause unacceptable interactions with other materials present in an oil well.

The tracers of the present invention are desirably compatible with the fluids wherein they are used. Preferably, the tracer selected is chosen to be more compatible with the injected materials than with the reservoir fluids which may recovered concurrently with the injected materials. The fluorinated benzoic acids are particularly preferred as tracers for the present invention because they are compatible in both aqueous fluids as a salt and in organic based fluids as an acid.

In an alternative embodiment of the present invention, more than one tracer can be used to measure multiple operations in the same well. For example, oil wells often have more than one producing strata or zone. In the practice of the present invention, a fracture job could be done on one strata using a first tracer and a fracture job could be done on another strata using a second tracer. In recent years, horizontal drilling has allowed for the drilling of multiple bores terminating in a common bore which connects to the surface. In multilateral wells such as these, several different tracers could be used to keep track of concurrent recovery of materials from the several legs (lateral bores) of such wells.

In a similar but different embodiment, the method of the present invention is used in a process to fracture stimulate multiple intervals in single or multiple formations, within the same wellbore. This is performed by: (i) perforating a first interval; (ii) stimulating that first interval; (iii) isolating the first interval, (iv) perforating a second interval; (v) stimulating the second interval; (iii) isolating the second interval; and continuing this pattern. There may be as many as 12 or 13 such stimulations done on a single wellbore in a short period of time, sometimes only weeks or even days. The operator of the well will then retrieves the isolation mechanism, typically a bridge plug, between each interval and begins to clean up all of the stimulated intervals, often at one time. The method of the present invention is very useful in such an operation because a different tracer can be used in each interval and thus can be individually detected during the flowback. The method of the present invention thereby provides an opportunity for a well operator to determine which to what extent each of the intervals is contributing to the flowback.

In the practice of the present invention, a tracer is admixed with a material that is to be injected into an oil well. The tracer can be premixed with the injection material or it can be admixed as it is injected. Preferably the tracer is admixed with the injection material through a static mixer as the admixture is pumped into the oil well. Any method known to those of ordinary skill in the art of admixing and injecting materials into oil wells can be used with the method of the present invention.

In one preferred embodiment, where a stream of fluids used for a hydraulic fracture job is being pumped into an oil well, a ten percent solution of a fluorinated benzoic acid salt tracer is pumped into the stream of fluids being used for a hydraulic fracture job, just upstream of a static mixer, using a peristaltic pump to meter the tracer into the stream of fluids. In another preferred embodiment, the pump used to feed the tracer solution into the fracture fluids is a triplex or

a centrifugal pump. In either embodiment, the metering pump is adjusted such that the tracer is injected into the fracture fluids at a rate that results in a predetermined tracer concentration appropriate for the conditions in the oil well. The same process can also be used for injecting tracer into a stream of drilling fluids.

In the practice of the present invention, the chemical tracer compound is admixed with a material to be injected into an oil well at a predetermined concentration. The concentration of the tracer is above its detection limits and preferably at a concentration of ten times its detection limits. In the practice of the present invention, preferably the concentrations of the tracer and the total amount of admixture injected is determined and known.

After the fluid injected into an oil well during the practice of the present invention has performed its purpose, it is preferably recovered. Most often, the injected materials are recovered along with reservoir fluids as a production fluid. In the practice of hydraulic fracturing of wells, this phase of the process is the fracture clean up. In conventional practices, this process can take an extended amount of time where up to 72 hours would not be unusual.

In the practice of the present invention, the recovered materials are tested for tracer concentration and the amount of material recovered determined. At this point, the well operator can make an informed decision regarding whether to continue clean up or begin production.

The extent of recovery of materials injected including a tracer of the present invention is preferably determined by using a mass balance approach. Therein, the total amount of tracer admixed with the injected material is a known. A homogenous sample of production fluid is tested for tracer concentration and the amount of tracer recovered is thereby determined. The amount of injected admixture recovered is then determined using the formula:

$$AMT_r=((T_r/T_i)\times AMT_i)$$

wherein AMT_r is the amount of injected admixture recovered, T_i is the amount of tracer injected; T_r is the amount of tracer recovered; and AMT_i is the amount of materials injected. T_r is determined by multiplying the concentrations of the tracer in the production fluid by the total quantity of production fluid recovered.

Where a mass balance approach is not possible or desirable, a relative rate of recovery can also be determined by measuring the concentration of tracer in the production fluids recovered from an oil well as a function of time. In a process such as this, samples of production fluid being recovered from the well are taken, analyzed for tracer concentration that is then plotted against time and/or flow rates. This can also be a desirable way for an operator to decide when to begin production from an oil well.

The tracers used with the method of the present invention can be analyzed by any method known to those of ordinary skill in the art of doing such analyses to be useful. For example, in one method of analyzing for a fluorinated benzoic acid tracer of the present invention, an emulsion of hydrocarbons, water and naturally occurring inorganic materials is first acidified with dilute hydrochloric acid and then extracted using a nonpolar solvent. The organic phase is then admixed with a 1 normal sodium hydroxide solution and then extracted with water. The water is then reacidified and extracted with methylene chloride. The recovered methylene chloride is then analyzed for the tracer, optionally after being reduced in volume by evaporation.

In addition to methylene chloride, other solvents can be used. For example, cyclohexane, normal hexane, pentane,

can be used. While not preferred, organic solvents such as benzene and toluene can also be used as long as care is used to make sure that the solvent does not have a significant background level of the tracer being used.

In the case of the fluorinated benzoic acid tracers, very low levels of tracer can be determined by taking advantage of the carboxylate group to first separate the tracer from non-acidic organics as a salt and then, in a second step, concentrate the tracer into an organic solvent by returning it to its acid form and then extracting it from an aqueous phase.

There are many instrumental methods of analyzing for the tracer compounds useful with the method of the present invention, including but not limited to, gas chromatography (GC) using flame ionization detectors, electron capture detectors, and the like; liquid chromatography (LC); infrared spectroscopy; combination instrumentation such as Fourier transform infrared spectroscopy, GC-mass spectroscopy, LC-mass spectroscopy, and the like.

When especially demanding analytical conditions arise, other means of doing the analyses can also be used, including using biologically active tracers for immunoassay, preparing functional derivatives of the tracers including, for example, esterifacation with more easily analyzed alcohols, and the like.

To achieve low levels of detection, it is necessary that standard laboratory practices be maintained. Fluids produced from oil wells can contain hazardous or toxic materials and steps should be taken to ensure the safety of lab personnel including, but not limited to, avoiding fire hazards, scrubbing or removing H_2S and other harmful gasses, and limiting skin contact with possible carcinogens. Quality assurance should be done as with any analytical procedure including using internal standards, external standards, and the like to ensure the accuracy of analyses. Recovery efficiencies can vary from oil well to oil well. It is important not to overlook simple steps such as accurately measuring sample volumes and filtering irrelevant solids from samples prior to analysis. Any analytical method that can detect the chemical tracers useful with the method of the present invention at useful levels can be used with the present invention.

In another embodiment of the present invention, the tracer is in the form of a coating on a solid substrate. In this application, the tracer is released gradually into production fluid over time. When co-injected with solids such as proppant or pack sand, this use of the tracers of the present invention would allow for an estimation of the amount of co-injected solids in place in the well. If too little tracer were detected after completion of the injection, or if the tracer level decreased too quickly after completion, an oil well operator would know that the injected solids were either not properly placed in the well or are being washed out or otherwise being removed from the oil well.

EXAMPLE

The following examples are provided to illustrate the present invention. The examples are not intended to limit the scope of the present invention and they should not be so interpreted. Amounts are in weight parts or weight percentages unless otherwise indicated.

A field application of the method of the present invention is performed in an oil and gas well penetrating the Codell formation in Weld County, Colo. A first material (referred to in the art of hydraulic fracturing as a "stage" or, in this case, "the first stage") is prepared for fracture injection into the well including 0.15 gallons per thousand gallons (gpt) buffer and 1 gpt of GBW23L* which is a high temperature oxi-

dizing gel breaker, 40 pounds per thousand pounds (ppt) gelling agent, and a first fluorinated benzoic acid tracer; in water. A second stage is prepared which includes 1-to-2 lbs/gal proppant; 0.15 gpt buffer; 1 gpt of GBW23L; 1 gpt BC31* gel breaker activator which is a low temperature oxidizing breaker activator; 40 ppt gelling agent; a second fluorinated benzoic acid tracer; and 2.5 (ppt) gel stabilizer, in water. A third stage is prepared which includes 3 lbs/gal proppant; 40 ppt gelling agent; 0.20 gpt buffer; 1 gpt GBW23L; 1 gpt BC31; 1 ppt Ultra Perm* breaker which is a low temp oxidizing breaker; 1 ppt gel stabilizer; a third fluorinated benzoic acid tracer; and 1.5 ppt gel crosslinking agent, in water. A fourth stage is prepared which includes 4 lbs/gal proppant; 40 ppt gelling agent; 0.20 gpt buffer; 3 ppt GBW5 breaker which is a low temp oxidizing breaker; a fourth fluorinated benzoic acid tracer, and 1 ppt Ultra Perm.

*GBW-23L, BC31, GBW5 and Ultra Perm are trade designations of BJ Services.

Each stage is injected, in turn, under fracture injection conditions. The flow back is tested for the presence and relative concentration of each tracer using a GC-mass spectrometer. The comparative amounts of tracer returned are: (A) Fourth fluorinated benzoic acid tracer highest concentration; (B) Second fluorinated benzoic acid tracer next highest concentration; (C) First fluorinated benzoic acid tracer next highest concentration; and (D) Third fluorinated benzoic acid tracer lowest concentration.

While not wishing to be bound by any theory, it can be concluded that the third material injected had the most stable gel structure, effectively locking it into the formation and thus had the lowest flow back and resulting in the lowest recovery of tracer. It can also be concluded that the fourth material, being last injected and replete with gel breaking materials would have the greatest flowback and thus the highest recovery of tracers.

What is claimed is:

1. A method for determining the extent of recovery of materials injected into a oil well comprising the steps of:

a) preparing a material to be injected into an oil well;

b) admixing therewith a chemical tracer compound at a predetermined concentration;

c) injecting the admixture into an oil well;

d) recovering from the oil well a production fluid;

e) analyzing the production fluid for the concentration of the chemical tracer present in the production fluid; and

f) calculating the amount of admixture recovered from the oil well using the concentration of the chemical tracer present in the production fluid as a basis for the calculation.

2. The method of claim **1** wherein the tracer is selected from the group consisting of fluorinated benzoic acids, perfluoromethylcyclopentane (PMCP), perfluoromethylcyclohexane (PMCH), perfluorodimethylcyclobutane (PDMCB), m-perfluorodimethylcyclohexane (m-PDMCH), o-perfluorodimethylcyclohexane (o-PDMCH), p-Perfluorodimethylcyclohexane (p-PDMCH), perfluorotrimethylcyclohexane (PTMCH), perfluoroethylcyclohexane (PECH), and perfluoroisopropylcyclohexane (IPPCH).

3. The method of claim **2** wherein the tracer is a fluorinated benzoic acid.

4. The method of claim **3** wherein the fluorinated benzoic acid is selected from the group consisting of including 2-fluorobenzoic acid; 3-fluorobenzoic acid; 4-fluorobenzoic acid; 3,5-difluorobenzoic acid; 3,4-difluorobenzoic acid; 2,6-difluorobenzoic acid; 2,5-difluorobenzoic acid; 2,3-difluorobenzoic acid; 2,4-difluorobenzoic acid; pentafluorobenzoic acid; 2,3,4,5-tetrafluorobenzoic acid; 4-(trifluoromethyl)benzoic acid; 2-(trifluoromethyl)benzoic acid; 3-(trifluoro-methyl)benzoic acid; 3,4,5-trifluorobenzoic acid; 2,4,5-trifluorobenzoic acid; 2,3,4-trifluorobenzoic acid; 2,3,5-trifluorobenzoic acid; 2,3,6-trifluorobenzoic acid; and 2,4,6-trifluorobenzoic acid.

5. The method of claim **1** wherein the tracer is present in the mixture injected into an oil well at a concentration of at least about 1 part per trillion.

6. The method of claim **5** wherein the tracer is present in the mixture injected into an oil well at a concentration of less than or equal to 10,000 parts per million.

7. The method of claim **6** wherein the tracer is present in the mixture injected into an oil well at a concentration of from about 100 parts per trillion to about 100 parts per million.

8. The method of claim **1** wherein the material injected into the oil well is a material useful for hydraulically fracturing the oil well.

9. The method of claim **1** wherein the amount of injected admixture recovered is determined using the formula:

$$AMT_r=((T_r/T_i)\times AMT_i)$$

Wherein:

(i) AMT_r is the amount of injected admixture recovered,

(ii) T_i is the amount of tracer injected;

(iii) T_r is the amount of tracer recovered;

(iv) AMT_i is the amount of admixture injected; and

(v) T_r is determined by multiplying the concentrations of the tracer in the production fluid by the total quantity of production fluid recovered.

10. The method of claim **1** wherein the tracer is in the form of a coating on a solid support.

11. A method for determining the extent of recovery of materials injected into a oil well comprising the steps of:

a) preparing a material to be injected into an oil well;

b) admixing therewith a chemical tracer compound at a predetermined concentration;

c) injecting the admixture into an oil well;

d) recovering from the oil well a production fluid;

e) analyzing the production fluid for the concentration of the chemical tracer present in the production fluid; and

f) calculating the amount of admixture recovered from the oil well using the concentration of the chemical tracer present in the production fluid as a basis for the calculation,

wherein the tracer is a fluorinated benzoic acid.

* * * * *

US007032662B2

(12) **United States Patent**
Malone et al.

(10) **Patent No.: US 7,032,662 B2**
(45) **Date of Patent: *Apr. 25, 2006**

(54) **METHOD FOR DETERMINING THE EXTENT OF RECOVERY OF MATERIALS INJECTED INTO OIL WELLS OR SUBSURFACE FORMATIONS DURING OIL AND GAS EXPLORATION AND PRODUCTION**

(75) Inventors: **Scott Malone**, Highlands Ranch, CO (US); **Earuch Broacha**, Tulsa, OK (US); **Don Shaw**, Denver, CO (US); **Tom Hampton**, Houston, TX (US)

(73) Assignee: **Core Laboratories LP**, Houston, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 240 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **10/706,654**

(22) Filed: **Nov. 12, 2003**

(65) **Prior Publication Data**

US 2004/0094297 A1 May 20, 2004

Related U.S. Application Data

(63) Continuation-in-part of application No. 10/154,130, filed on May 23, 2002, now Pat. No. 6,659,175.

(60) Provisional application No. 60/293,071, filed on May 23, 2001.

(51) **Int. Cl.**
E21B 43/267 (2006.01)
E21B 47/00 (2006.01)
G01N 33/24 (2006.01)

(52) **U.S. Cl.** **166/252.6**; 73/152.42; 166/250.1; 166/250.12; 166/280.2; 507/267; 507/907; 507/924

(58) **Field of Classification Search** 166/250.1, 166/250.12, 252.6, 280.2, 308.2; 73/152.42; 175/40, 42; 250/259, 260; 436/27, 28, 29; 507/267, 906, 907, 922, 924
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,207,348	A	7/1940	Jones et al.	436/29
2,869,642	A	1/1959	McKay et al.	166/250.01
3,059,909	A	10/1962	Wise	261/39
3,180,142	A	4/1965	Bombarieri	73/152.18
3,301,723	A	1/1967	Chrisp	149/20
3,316,965	A	5/1967	Watanabe	
3,492,147	A	1/1970	Young et al.	427/5
3,856,468	A	12/1974	Keller	436/27
3,888,312	A	6/1975	Tiner et al.	
3,902,362	A	9/1975	Tomich et al.	73/155
4,055,399	A	10/1977	Parrish	23/230 EP
4,273,187	A	6/1981	Satter et al.	
4,352,674	A	10/1982	Fery	436/27
4,373,586	A	2/1983	Hunt, III	166/263
4,415,805	A	11/1983	Fertl et al.	250/260
4,681,245	A	7/1987	Harvey	222/643
4,807,469	A	2/1989	Hall	73/152.19
4,840,292	A	6/1989	Harvey	222/1
5,049,743	A	9/1991	Taylor et al.	250/303
5,077,471	A	12/1991	Smith, Jr. et al.	250/260
5,246,860	A	9/1993	Hutchins et al.	436/27
5,279,967	A	1/1994	Bode	436/56
5,410,152	A	4/1995	Gadeken	250/260
5,439,055	A *	8/1995	Card et al.	166/280.2
5,855,243	A *	1/1999	Bragg	166/275
5,929,437	A	7/1999	Elliott et al.	250/259
5,986,030	A	11/1999	Murray et al.	526/268
6,003,365	A	12/1999	Pope et al.	73/152.39
6,016,191	A	1/2000	Ramos et al.	356/70
6,025,200	A	2/2000	Kaish et al.	436/56
6,075,611	A	6/2000	Dussan V. et al.	356/432
6,076,046	A	6/2000	Vasudevan et al.	702/12
6,125,934	A	10/2000	Lenn et al.	166/250.12
6,148,913	A	11/2000	Collins	166/263
6,192,985	B1	2/2001	Hinkel et al.	166/280
6,645,769	B1 *	11/2003	Tayebi et al.	436/56
2001/0036667	A1 *	11/2001	Tayebi et al.	436/56
2002/0020527	A1 *	2/2002	Kilaas et al.	166/250.01

FOREIGN PATENT DOCUMENTS

WO WO 02/095189 * 11/2002

OTHER PUBLICATIONS

Michael C. Adams et al.; *Thermal Stabilities of Aromatic Acids as Geothermal Tracers*, http://www.egi.utah.edu/geothermal/Tracer/T_Studies/, Sep. 21, 1998, pp. 1-23, 3 pages of references.

Michael C. Adams et al.; *The Dixie Valley, Nevada Tracer Test*, ESL—93011—PR, http://www.egi.utah.edu/geothermal/Tracer/T_Studies/, Mar. 3, 1998, Table of Contents, pp. 1-11, Appendix A, Appendix B.

(Continued)

Primary Examiner—George Suchfield
(74) *Attorney, Agent, or Firm*—Madan, Mossman & Sriram, P.C.

(57) **ABSTRACT**

Disclosed is a method of determining the extent of recovery of materials injected into oil wells or subsurface formations. The method includes injection of one or more tracers into an oil well or into a formation. Included in the method are the steps of introducing a material of interest into the oil well or into the subsurface formation associated with the bore of the oil well; introducing a tracer into the oil well or into the subsurface formation associated with the bore of the oil well; recovering from the oil well a production fluid, analyzing the production fluid for a concentration of the chemical tracer present in the production fluid; and calculating the amount of material of interest recovered from the oil well using the concentration of the chemical tracer present in the production fluid as a basis for the calculation.

21 Claims, No Drawings

OTHER PUBLICATIONS

Michael C. Adams et al.; *Kinetics of Fluorscein Decay and Its Application as a Geothermal Tracer*, http://www.egi.utah.edu/geothermal/Tracer/T_Studies/, Mar. 3, 1998, pp. 1-27.

Michael C. Adams et al.; *The Application of Halogenated Alkanes as Vapor-Phase Tracers: A Field Test in the Southeast Geysers*, http://www.egi.utah.edu/geothermal/Tracer/T_Studies/, Mar. 3, 1998, 9 pgs.

Joseph J. Beall et al.; *R-13 Tracing of Injection in the Geysers*, http://www.egi.utah.edu/geothermal/Tracer/T_Studies/, Mar. 3, 1998, pp. 1-11.

Michael C. Adams et al., *Rhodamine WT as a Geothermal Tracer—A Field Test a Steamboat Hills*, Nevada, http://www.egi.utah.edu/geothermal/Tracer/T_Studies/, Mar. 3, 1998, 13 pgs.

Alcohols, http://www.egi.utah.edu/geothermal/Tracer/T_Studies/,Mar. 3, 1998.

Claus Ulrich Galdiga; *Trace Analysis of Fluorinated Aromatic Carboxylic Acids in Aqueous Reservoir Fluids by HPLC*, J. Liq. Chrom. & Rel. Technol., 21(6), pp. 855-868 (1998).

Ofer Dahan et al.; *Analytical Procedure for Simultaneous Use of Seven Fluorobenzoates in Multitracer Tests*, vol. 39, No. 3, Ground Water, May-Jun. 2001, pp. 366-370, 2 Tables, 5 Figs.

T. Bjørnstad et al.; *Interwell Tracer Technology in Oil Reservoirs*: State-of-the-Art, pp. 261-268, 3 Tables, 2 Figs.

Tor Bjørnstad; *Recent and Current Oil Field Tracer Development for Interwell Application*2nd Tracer Workshop, University of Texas at Austin, Nov. 14&15, 1994, pp. 101-112, 2 Table, 18 Figs..

Joseph S. Tang; *Partitioning Tracers and In-Situ Fluid-Saturation Measurements*, SPE Formation Evaluation, Mar. 1995, pp. 33-39, 11 Figs.

Claus Ulrich Galdiga et al.; *Ultra trace determination of fluorinated aromatic carboxylic acids in aqueous reservoir fluids by solid phase extraction in combination with negative ion chemical ionisation mass spectrometry after derivatisation with pentafluorobenzyl bromide* Fresenius J. Anal Chem (1998) 361:797-802pp. 795-802, 3 Tables, 4 Figs..

* cited by examiner

METHOD FOR DETERMINING THE EXTENT OF RECOVERY OF MATERIALS INJECTED INTO OIL WELLS OR SUBSURFACE FORMATIONS DURING OIL AND GAS EXPLORATION AND PRODUCTION

RELATED APPLICATIONS

This application is a continuation-in-part of U.S. patent application Ser. No. 10/154,130, filed on May 23, 2002 now U.S. Pat. No. 6,659,175 which application claims priority from U.S. Provisional Patent Application Ser. No. 60/293, 071 filed on May 23, 2001.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method for determining the extent of recovery of materials injected into an oil well during oil and gas exploration and production. The present invention particularly relates to a method for determining the extent of recovery of materials injected into an oil well during oil and gas exploration and production using chemical tracers.

2. Background of the Art

The present Invention relates generally to hydrocarbon (oil and gas) production from wells drilled in the earth, hereinafter referred to as "oil wells." Drilling a hole into the earth to reach oil and gas bearing formations is expensive which limits the number of wells that can be economically drilled. It follows then that it is desirable to maximize both and the overall recovery of hydrocarbon held in the formation and the rate of flow from the subsurface formation to the surface, where it can be recovered.

One way in which to maximize production is the process known as fracturing. Hydraulic fracturing involves literally breaking or fracturing a portion of the hydrocarbon bearing formation surrounding an oil well by injecting a specialized fluid into the wellbore directed at the face of the geologic formation at pressures sufficient to initiate and/or extend a fracture in the formation. Ideally, what this process creates is not a single fracture, but a fracture zone, i.e., a zone having multiple fractures, or cracks in the formation, through which hydrocarbon can more readily flow to the wellbore.

Creating a fracture in a hydrocarbon-bearing formation requires several materials. Often these materials, if not removed from the oil well, can interfere with oil and gas production. Even the drilling mud used to lubricate a drill bit during the drilling of an oil well can interfere with oil and gas production. Taking too long to remove such materials can increase the cost to the operator of the well by delaying production and causing excess removal expenses. Not being thorough in removing such materials can increase the cost to the operator of the well through lower production rates and possible lost production.

Measures taken to remove unwanted or unneeded materials are usually inexact. Sometimes additional fluids are used to flush out unwanted materials in the well bore. In other situations, reservoir fluids flow can make estimating return flow very difficult, particularly if the reservoir fluids are incompatible with the injected materials. It would be desirable in the art of oil and gas production to be able to determine how much of a given material is left in an oil well after a drilling, fracturing or any other operation requiring the injection of materials into an oil well. It would be

particularly desirable if such a determination could be made using an inexpensive and environmentally benign method.

SUMMARY OF THE INVENTION

In one aspect, the present invention is a method for determining the extent of recovery of materials injected into an oil well comprising the steps of: a) admixing a material to be injected into an oil well with a chemical tracer compound at a predetermined concentration; b) injecting the admixture into an oil well or an offset well associated with an oil well; c) recovering from the oil well a production fluid; d) analyzing the production fluid for the concentration of the chemical tracer present in the production fluid; and e) calculating the amount of admixture recovered from the oil well using the concentration of the chemical tracer present in the production fluid as a basis for the calculation.

In another aspect, the present invention is a method for determining the extent of recovery of a material of interest injected into an oil well or a subsurface formation associated with a bore of the oil well comprising the steps of: a) introducing a material of interest into the oil well or into the subsurface formation associated with the bore of the oil well; b) introducing a tracer into the oil well or into the subsurface formation associated with the bore of the oil well; c) recovering from the oil well a production fluid; d) analyzing the production fluid for the concentration of the chemical tracer present in the production fluid; and e) calculating the amount of material of interest recovered from the oil well using the concentration of the chemical tracer present in the production fluid as a basis for the calculation.

DESCRIPTION OF PREFERRED EMBODIMENTS

As already defined, the term "oil well" means hydrocarbon (oil and gas) production wells drilled in the earth. The method of the present invention can also be used with other types of wells that are drilled in the earth and can require stimulation by hydraulic fracturing, such as a well used for water flooding in secondary recovery operations in oil and gas production. For the purposes of the present invention, the term "oil well" means hydrocarbon production wells, such as those that can require stimulation by hydraulic fracturing but also means any other type of well used in oil and gas production. The method of the present invention can be used in either gas wells or oil wells, as well as in those wells producing significant quantities of both oil and gas.

In one embodiment, the present invention is a method for determining the amount of fracture materials recovered after the stimulation of an oil well by means of hydraulic fracturing. Creating a fracture in a hydrocarbon-bearing formation requires several materials. Most often these include a carrier fluid, a viscosifier, a proppant, and a breaker. Other components that are sometimes added include materials to control leak-off, or migration of the fluid into the fracture face, gel stabilizers, surfactants, clay control agents and crosslinkers.

The purpose of the first fracturing component is to first create/extend a fracture in an oil and gas producing formation and then, once it is opened enough, to deliver proppant. The carrier fluid together with proppant material is injected into the fractured formation. The carrier fluid is simply the means by which the proppant and breaker are carried into the formation.

Numerous substances can act as a suitable carrier fluid, though they are generally aqueous-based solutions that have

been either gelled or foamed or both. Thus, the carrier fluid is often prepared by blending a polymeric gelling agent with an aqueous solution although sometimes the carrier fluid is oil-based or a multi-phase fluid. Often, the polymeric gelling agent is a solvatable polysaccharide, e.g. galactomannan gums, glycomannan gums, and cellulose derivatives. The purpose of the solvatable or hydratable polysaccharides is to thicken the aqueous solution so proppant can be suspended in the solution for delivery into the fracture.

The polysaccharides function as viscosifiers, increasing the viscosity of the aqueous solution by 10 to 100 times, or even more. During high temperature applications, a cross-linking agent is further added which further increases the viscosity of the solution. The borate ion has been used extensively as a crosslinking agent for hydrated guar gums and other galactomannans to form aqueous gels, e.g., U.S. Pat. No. 3,059,909. Other demonstrably suitable cross-linking agents include: titanium as disclosed in U.S. Pat. No. 3,888,312, chromium, iron, aluminum, and zirconium as disclosed in U.S. Pat. No. 3,301,723. More recently, viscoelastic surfactants have been developed which obviates the need for thickening agents, and hence cross-linking agents.

Most relevant to the present invention is the final step of the fracturing process. The process of removing the fluid from the fracture once the proppant has been delivered is referred to as "fracture clean-up." For this, the final component of the fracture fluid becomes relevant: the breaker. The purpose of the breaker is to lower the viscosity of the fluid so that it is more easily removed from the fracture.

In another aspect, the present invention is a method for determining the amount of drilling fluid recovered after the completion of an oil well. A drilling fluid is a fluid specially designed to be circulated through a wellbore as the wellbore is being drilled to facilitate the drilling operation. The circulation path of the drilling fluid typically extends from the wellhead down through the drill pipe string to the drilling face and back up through the annular space between the drill pipe string and wellbore face to the wellhead. The drilling fluid performs a number of functions as it circulates through the wellbore including cooling and lubricating the drill bit, removing drill cuttings from the wellbore, aiding in support of the drill pipe and drill bit, and providing a hydrostatic head to maintain the integrity of the wellbore walls and prevent well blowouts.

There are a number of different types of conventional drilling fluids including compositions termed "drilling muds." Drilling muds comprise high-density dispersions of fine solids in an aqueous liquid or a hydrocarbon liquid. An exemplary drilling mud is a dispersion of clay and/or gypsum in water. The solid component of such a dispersion is termed a "weighting agent" and is designed to enhance the functional performance of the drilling fluid.

In the practice of the present invention, the extent of recovery of materials injected into a oil well during fracturing, drilling and the like is determined by preparing the fracture materials or drilling fluids to be injected into an oil well and admixing therewith a chemical tracer compound at a predetermined concentration. The tracer acts as a model for determining the amount of these materials recovered. For purposes of the present invention, these materials are referred to as the materials for which the tracers are used as a model and sometimes just as the materials of interest.

The tracers useful with the present invention include any known to those ordinary skill in the art of using chemical tracers in oil and gas operations to be useful, but preferably are those which can be detected at concentrations low enough to make their use economically practical in such operations and low enough to interfere with the carrier fluid or other materials present in the oil well. Preferably the chemical tracers useful with the present invention include but are not limited to: fluorinated benzoic acids including 2-fluorobenzoic acid; 3-fluorobenzoic acid; 4-fluorobenzoic acid; 3,5-difluorobenzoic acid; 3,4-difluorobenzoic acid; 2,6-difluorobenzoic acid; 2,5-difluorobenzoic acid; 2,3-difluorobenzoic acid; 2,4-difluorobenzoic acid; pentafluorobenzoic acid; 2,3,4,5-tetrafluorobenzoic acid; 4-(trifluoromethyl)benzoic acid; 2-(trifluoromethyl)benzoic acid; 3-(trifluoromethyl)benzoic acid; 3,4,5-trifluorobenzoic acid; 2,4,5-trifluorobenzoic acid; 2,3,4-trifluorobenzoic acid; 2,3,5-trifluorobenzoic acid; 2,3,6-trifluorobenzoic acid; 2,4,6-trifluorobenzoic acid; and the like, perfluoromethylcyclopentane (PMCP), perfluoromethylcyclohexane (PMCH), perfluorodimethylcyclobutane (PDMCB), m-perfluorodimethylcyclohexane (m-PDMCH), o-perfluorodimethylcyclohexane (o-PDMCH), p-Perfluorodimethylcyclohexane (p-PDMCH), perfluorotrimethylcyclohexane (PTMCH), perfluoroethylcyclohexane (PECH), perfluoroisopropylcyclohexane (IPPCH), and the like.

Any chemical compound can be used as tracer with the present invention if: it is not present at a measurable level in the reservoir fluids being produced from the Well being tested, it can be measured at levels sufficiently low to allow its use to be economical, and the tracer does not interfere or interact undesirably with other materials present in the oil well at the levels used. Preferably, the tracers are detectable at a range of from about 1 parts per trillion to about 10,000 parts per million in the fluid being analyzed. Preferably the tracers are detectable at a range of from 5 parts per trillion to about 1,000 parts per million. More preferably the tracers are detectable at a range of from 100 parts per trillion to about 100 parts per million. At concentrations greater than about 1000 parts per million, the use of some tracers can become prohibitively expensive or cause unacceptable interactions with other materials present in an oil well.

In one embodiment of the present invention, the tracers are desirably compatible with the fluids wherein they are used. Preferably, the tracer selected is chosen to be more compatible with the injected materials than with the reservoir fluids which may recovered concurrently with the injected materials. The fluorinated benzoic acids are particularly preferred as tracers for the present invention because they are compatible in both aqueous fluids as a salt and in organic based fluids as an acid.

In an alternative embodiment of the present invention, more than one tracer can be used to measure multiple operations in the same well. For example, oil wells often have more than one producing strata or zone. In the practice of the present invention, a fracture job could be done on one strata using a first tracer and a fracture job could be done on another strata using a second tracer. In recent years, horizontal drilling has allowed for the drilling of multiple bores terminating in a common bore which connects to the surface. In multilateral wells such as these, several different tracers could be used to keep track of concurrent recovery of materials from the several legs (lateral bores) of such wells.

In a similar but different embodiment, the method of the present invention is used in a process to fracture stimulate multiple intervals in single or multiple formations, within the same wellbore. This is performed by: (i) perforating a first interval; (ii) stimulating that first interval; (iii) isolating the first interval, (iv) perforating a second interval; (v) stimulating the second interval; (iii) isolating the second interval; and continuing this pattern. There may be as many

as 12 or 13 such stimulations done on a single wellbore in a short period of time, sometimes only weeks or even days. The operator of the well will then retrieves the isolation mechanism, typically a bridge plug, between each interval and begins to clean up all of the stimulated intervals, often at one time. The method of the present invention is very useful in such an operation because a different tracer can be used in each interval and thus can be individually detected during the flowback. The method of the present invention thereby provides an opportunity for a well operator to determine which to what extent each of the intervals is contributing to the flowback.

In the practice of the present invention, a tracer is admixed with a material that is to be injected into an oil well. The tracer can be premixed with the injection material or it can be admixed as it is injected. Preferably the tracer is admixed with the injection material through a static mixer as the admixture is pumped into the oil well. Any method known to those of ordinary skill in the art of admixing and injecting materials into oil wells can be used with the method of the present invention.

In one preferred embodiment, where a stream of fluids used for a hydraulic fracture job is being pumped into an oil well, a ten percent solution of a fluorinated benzoic acid salt tracer is pumped into the stream of fluids being used for a hydraulic fracture job, just upstream of a static mixer, using a peristaltic pump to meter the tracer into the stream of fluids. In another preferred embodiment, the pump used to feed the tracer solution into the fracture fluids is a triplex or a centrifugal pump. In either embodiment, the metering pump is adjusted such that the tracer is injected into the fracture fluids at a rate that results in a predetermined tracer concentration appropriate for the conditions in the oil well. The same process can also be used for injecting tracer into a stream of drilling fluids.

In the practice of the present invention, the chemical tracer compound is admixed with a material to be injected into an oil well at a predetermined concentration. The concentration of the tracer is above its detection limits and preferably at a concentration of ten times its detection limits. In the practice of the present invention, preferably the concentrations of the tracer and the total amount of admixture injected is determined and known.

After the fluid injected into an oil well during the practice of the present invention has performed its purpose, it is preferably recovered. Most often, the injected materials are recovered along with reservoir fluids as a production fluid. In the practice of hydraulic fracturing of wells, this phase of the process is the fracture clean up. In conventional practices, this process can take an extended amount of time where up to 72 hours would not be unusual.

In the practice of the present invention, the recovered materials are tested for tracer concentration and the amount of material recovered determined. At this point, the well operator can make an informed decision regarding whether to continue clean up or begin production. An advantage of the present invention is that it allows the well operator to avoid unnecessary down time, but prevents premature termination of clean up operations. Down time and premature termination of clean up operations can be very expensive to well operators.

The extent of recovery of materials injected including a tracer of the present invention is preferably determined by using a mass balance approach. Therein, the total amount of tracer admixed with the injected material is a known. A homogenous sample of production fluid is tested for tracer concentration and the amount of tracer recovered is thereby determined. The amount of injected admixture recovered is then determined using the formula:

$$AMT_r=((T_r/T_i)\times AMT_i)$$

wherein AMT_r is the amount of injected admixture recovered, T_i is the amount of tracer injected; T_r is the amount of tracer recovered; and AMT_i is the amount of materials injected. T_r is determined by multiplying the concentrations of the tracer in the production fluid by the total quantity of production fluid recovered.

Where a mass balance approach is not possible or desirable, a relative rate of recovery can also be determined by measuring the concentration of tracer in the production fluids recovered from an oil well as a function of time. In a process such as this, samples of production fluid being recovered, from the well are taken, analyzed for tracer concentration that is then plotted against time and/or flow rates. This can also be a desirable way for an operator to decide when to terminate clean up and begin production from an oil well.

The tracers used with the method of the present invention can be analyzed by any method known to those of ordinary skill in the art of doing such analyses to be useful. For example, in one method of analyzing for a fluorinated benzoic acid tracer of the present invention, an emulsion of hydrocarbons, water and naturally occurring inorganic materials is first acidified with dilute hydrochloric acid and then extracted using a nonpolar solvent. The organic phase is then admixed with a 1 normal sodium hydroxide solution and then extracted with water. The water is then reacidified and extracted with methylene chloride. The recovered methylene chloride is then analyzed for the tracer, optionally after being reduced in volume by evaporation.

In addition to methylene chloride, other solvents can be used. For example, cyclohexane, normal hexane, pentane, can be used. While not preferred, organic solvents such as benzene and toluene can also be used as long as care is used to make sure that the solvent does not have a significant background level of the tracer being used.

In the case of the fluorinated benzoic acid tracers, very low levels of tracer can be determined by taking advantage of the carboxylate group to first separate the tracer from non-acidic organics as a salt and then, in a second step, concentrate the tracer into an organic solvent by returning it to its acid form and then extracting it from an aqueous phase.

There are many instrumental methods of analyzing for the tracer compounds useful with the method of the present invention, including but not limited to, gas chromatography (GC) using flame ionization detectors, electron capture detectors, and the like; liquid chromatography (LC); infrared spectroscopy; combination instrumentation such as Fourier transform infrared spectroscopy, GC-mass spectroscopy, LC-mass spectroscopy, and the like.

When especially demanding analytical conditions arise, other means of doing the analyses can also be used, including using biologically active tracers for immunoassay, preparing functional derivatives of the tracers including, for example, esterifacation with more easily analyzed alcohols, and the like.

To achieve low levels of detection, it is necessary that standard laboratory practices be maintained. Fluids produced from oil wells can contain hazardous or toxic materials and steps should be taken to ensure the safety of lab personnel including, but not limited to, avoiding fire hazards, scrubbing or removing H_2S and other harmful gasses, and limiting skin contact with possible carcinogens. Quality assurance should be done as with any analytical procedure

including using internal standards, external standards, and the like to ensure the accuracy of analyses. Recovery efficiencies can vary from oil well to oil well. It is important not to overlook simple steps such as accurately measuring sample volumes and filtering irrelevant solids from samples prior to analysis. Any analytical method that can detect the chemical tracers useful with the method of the present invention at useful levels can be used with the present invention.

In another embodiment of the present invention, the tracer is in the form of a coating on a solid substrate or as a fluid or solid trapped in the pores of a porous support. The tracer can also be in the form of a pellet admixed with solids soluble in the production fluid. In these embodiments, the tracer is released gradually into production fluid over time. When co-injected with solids such as proppant or pack sand, this use of the tracers of the present invention would allow for an estimation of the amount of co-injected solids in place in the well. If too little tracer were detected after completion of the injection, or if the tracer level decreased too quickly after completion, an oil well operator would know that the injected solids were either not properly placed in the well or are being washed out or otherwise being removed from the oil well.

In a similar embodiment, the present invention can be practice wherein the tracer is in the form of an encapsulated liquid or solid. The encapsulating agent can selected from natural and synthetic oils, natural and synthetic polymers and enteric polymers and mixtures thereof. Preferably the encapsulating agent is selected from crosslinked vegetable oils, natural or synthetic polymers (such as polyvinylchloride and nylon), enteric polymers (such as acrylic resin polymers, cellulose acetate phthalate, carboxylated polymers, aqueous methacrylic polymers, and mixtures thereof.

The process of encapsulating the tracers of the present invention somewhat depends upon both the tracer and the encapsulating agent selected. In one embodiment the encapsulation process involves the coating of solid organic tracer with vegetable oil. One of skill in the art should be capable of accomplishing this by the combination of the tracer and vegetable oil in an agglomerator or other similar devise that coats solid particles with a protective coating. Alternatively the tracer can be encapsulated within polyvinylchloride or other polymers. There are many ways that those skilled in the art can encapsulate materials. Among these are in situ polymerization, interfacial polymerization, complex coacervation, polymer/polymer phase separation, desolvation, extrusion, thermal gelation, and ionic gelation. Any form of encapsulation known to those of ordinary skill in the art of encapsulation can be used with the present invention subject to the limitation that the encapsulation must release the tracer in a predictable manner one the tracer is downhole.

While the method of the present invention is particularly suitable for use with fracturing operations in an oil and gas well, it can be used with other types of operations and in other than just the main or primary production wellbore. For example, the method of the present invention can be used with chemical stimulation methods. Other stimulation methods that can be used with the present invention include, but are not limited to "break down"; "mini frac tests"; water block treatments; and in situ fluid compatibility testing for use with water based fluids. The method of the present invention can be used with almost any process wherein materials of interest are introduced to a wellbore and/or producing formation and wherein it would be desirable to be able to determine the extent that such materials have been recovered.

In one embodiment of the present invention, the tracers are introduced downhole into a production well. This is not the only way in which to practice the method of the present invention. In another embodiment, the tracers are introduced into the well using an offset well. An offset well is an existing wellbore close to the subject oil well that provides information for planning or operating the subject oil well. In this embodiment, the tracers and the materials for which the tracers are going to be used to model recovery can both be introduced into the formation using an offset well. In a related embodiment, the offset well can have a junction with the bore of a subject oil well. In still another embodiment, either one of the tracer or material for which the tracer will be a model can be injected into an offset well with the other material being introduced downhole through the subject oil well.

In a preferred embodiment, the tracers are admixed with the material for which they will serve as a model, but in another embodiment, the materials of interest and tracers are introduced separately. For example, the tracers of the present invention can be introduced downhole into an oil well or offset well using a dump bailer or other means of introducing small amounts of solids or slurries downhole. Downhole injection using a surface or even a subsurface pump is also within the scope of the present invention. The method of the present invention can be used with any scheme for introducing the material to be modeled and the tracers downhole so long as there is a known relationship between the tracers and the material for which the tracers will serve as a model that will allow for the calculation of recovery of the material of interest using the recovery of the tracers.

The following examples are provided to illustrate the present invention. The examples are not intended to limit the scope of the present invention and they should not be so interpreted. Amounts are in weight parts or weight percentages unless otherwise indicated.

EXAMPLE

A field application of the method of the present invention is performed in an oil and gas well penetrating the Codell formation in Weld County, Colorado. A first material (referred to in the art of hydraulic fracturing as a "stage" or, in this case, "the first stage") is prepared for fracture injection into the well including 0.15 gallons per thousand gallons (gpt) buffer and 1 gpt of GBW23L* which is a high temperature oxidizing gel breaker, 40 pounds per thousand pounds (ppt) gelling agent, and a first fluorinated benzoic acid tracer; in water. A second stage is prepared which includes 1-to-2 lbs/gal proppant; 0.15 gpt buffer; 1 gpt of GBW23L; 1 gpt BC31* gel breaker activator which is a low temperature oxidizing breaker activator; 40 ppt gelling agent; a second fluorinated benzoic acid tracer; and 2.5 (ppt) gel stabilizer, in water. A third stage is prepared which includes 3 lbs/gal proppant; 40 ppt gelling agent; 0.20 gpt buffer; 1 gpt GBW23L; 1 gpt BC31; 1 ppt Ultra Perm* breaker which is a low temp oxidizing breaker; 1 ppt gel stabilizer; a third fluorinated benzoic acid tracer; and 1.5 ppt gel crosslinking agent, in water. A fourth stage is prepared which includes 4 lbs/gal proppant; 40 ppt gelling agent; 0.20 gpt buffer; 3 ppt GBW5 breaker which is a low temp oxidizing breaker; a fourth fluorinated benzoic acid tracer, and 1 ppt Ultra Perm. *GBW-23L, BC31, GBW5 and Ultra Perm are trade designations of BJ Services.

Each stage is injected, in turn, under fracture injection conditions. The flow back is tested for the presence and relative concentration of each tracer using a GC-mass spec-

trometer. The comparative amounts of tracer returned are: (A) Fourth fluorinated benzoic acid tracer highest concentration; (B) Second fluorinated benzoic acid tracer next highest concentration; (C) First fluorinated benzoic acid tracer next highest concentration; and (D) Third fluorinated benzoic acid tracer lowest concentration.

While not wishing to be bound by any theory, it can be concluded that the third material injected had the most stable gel structure, effectively locking it into the formation and thus had the lowest flow back and resulting in the lowest recovery of tracer. It can also be concluded that the fourth material, being last injected and replete with gel breaking materials would have the greatest flowback and thus the highest recovery of tracers.

What is claimed is:

1. A method for determining the extent of recovery of materials injected into an oil well comprising:

a) admixing a material to be injected into an oil well with a chemical tracer compound at a predetermined concentration;

b) injecting the admixture into an oil well or an offset well associated with an oil well;

c) recovering from the oil well a production fluid;

d) analyzing the production fluid for a concentration of the chemical tracer present in the production fluid; and

e) calculating the amount of admixture recovered from the oil well using the concentration of the chemical tracer present in the production fluid as a basis for the calculation.

2. The method of claim **1** wherein the tracer is selected from the group consisting of fluorinated benzoic acids, perfluoromethylcyclopentane (PMCP), perfluoromethylcyclohexane (PMCH), perfluorodimethylcyclobutane (PDMCB), m-perfluorodimethylcyclohexane (m-PDMCH), o-perfluorodimethylcyclohexane (o-PDMCH), p-Perfluorodimethylcyclohexane (p-PDMCH), perfluorotrimethylcyclohexane (PTMCH), perfluoroethylcyclohexane (PECH), and perfluoroisopropylcyclohexane (IPPCH).

3. The method of claim **2** wherein the tracer is a fluorinated benzoic acid.

4. The method of claim **3** wherein the fluorinated benzoic acid is selected from the group consisting of including 2-fluorobenzoic acid; 3-fluorobenzoic acid; 4-fluorobenzoic acid; 3,5-difluorobenzoic acid; 3,4-difluorobenzoic acid; 2,6-difluorobenzoic acid; 2,5-difluorobenzoic acid; 2,3-difluorobenzoic acid; 2,4-difluorobenzoic acid; pentafluorobenzoic acid; 2,3,4,5-tetrafluorobenzoic acid; 4-(trifluoromethyl)benzoic acid; 2-(trifluoromethyl)benzoic acid; 3-(trifluoro-methyl)benzoic acid; 3,4,5-trifluorobenzoic acid; 2,4,5-trifluorobenzoic acid; 2,3,4-trifluorobenzoic acid; 2,3,5-trifluorobenzoic acid; 2,3,6-trifluorobenzoic acid; and 2,4,6-trifluorobenzoic acid.

5. The method of claim **1** wherein the tracer is present in the admixture injected into an oil well at a concentration of at least about 1 part per trillion.

6. The method of claim **5** wherein the tracer is present in the admixture injected into an oil well at a concentration of less than or equal to 10,000 parts per million.

7. The method of claim **6** wherein the tracer is present in the admixture injected into an oil well at a concentration of from about 100 parts per trillion to about 100 parts per million.

8. The method of claim **1** wherein the material injected into the oil well is a hydraulic fracturing fluid.

9. The method of claim **1** wherein the material injected into the oil well is a chemical stimulation fluid.

10. The method of claim **1** wherein the amount of injected admixture recovered is determined using the formula:

$$AMT_r=((T_r/T_i)\times AMT_i)$$

Wherein:

(i) AMT_r is the amount of injected admixture recovered,

(ii) T_i is the amount of tracer injected;

(iii) T_r is the amount of tracer recovered;

(iv) AMT_i is the amount of admixture injected; and

(v) T_r is determined by multiplying the concentrations of the tracer in the production fluid by the total quantity of production fluid recovered.

11. The method of claim **1** wherein the tracer is in the form of a coating on a solid support.

12. The method of claim **1** wherein the tracer is in the form of a liquid or solid within the pores of a porous support.

13. The method of claim **1** wherein the tracer is in the form of an encapsulated liquid or solid.

14. A method for determining the extent of recovery of a material of interest injected into an oil well or a subsurface formation associated with a bore of the oil well comprising:

a) introducing a material of interest into the oil well or into the subsurface formation associated with the bore of the oil well;

b) introducing a tracer into the oil well or into the subsurface formation associated with the bore of the oil well;

c) recovering from the oil well a production fluid;

d) analyzing the production fluid for a concentration of the chemical tracer present in the production fluid; and

e) calculating the amount of material of interest recovered from the oil well using the concentration of the chemical tracer present in the production fluid as a basis for the calculation.

15. The method of claim **14** wherein the tracer is a fluorinated benzoic acid.

16. The method of claim **15** wherein the fluorinated benzoic acid is selected from the group consisting of including 2-fluorobenzoic acid; 3-fluorobenzoic acid; 4-fluorobenzoic acid; 3,5-difluorobenzoic acid; 3,4-difluorobenzoic acid; 2,6-difluorobenzoic acid; 2,5-difluorobenzoic acid; 2,3-difluorobenzoic acid; 2,4-difluorobenzoic acid; pentafluorobenzoic acid; 2,3,4,5-tetrafluorobenzoic acid; 4-(trifluoro-methyl)benzoic acid; 2-(trifluoromethyl)benzoic acid; 3-(trifluoro-methyl)benzoic acid; 3,4,5-trifluorobenzoic acid; 2,4,5-trifluorobenzoic acid; 2,3,4-trifluorobenzoic acid; 2,3,5-trifluorobenzoic acid; 2,3,6-trifluorobenzoic acid; and 2,4,6-trifluorobenzoic acid.

17. The method of claim **16** wherein the tracer is introduced into the oil well or subsurface formation through the oil well.

18. The method of claim **16** wherein the tracer is introduced into the oil well or subsurface formation through an offset well.

19. The method of claim **16** wherein the material of interest is introduced into the oil well or subsurface formation through the oil well.

20. The method of claim **16** wherein the material of interest is introduced into the oil well or subsurface formation through an offset well.

21. The method of claim **14** wherein the amount of material of interest recovered is determined using the formula:

$$AMT_r=((T_r/T_i)\times AMT_i)$$

Wherein:

(i) AMT_r is the amount of material of interest recovered,

(ii) T_i is the amount of tracer injected;

(iii) T_r is the amount of tracer recovered;

(iv) AMT_i is the amount of material of interest injected; and

(v) T_r is determined by multiplying the concentrations of the tracer in the production fluid by the total quantity of production fluid recovered.

* * * * *

CERTIFICATE OF SERVICE

I hereby certify that true and correct copies of the foregoing *Brief for Appellant* were caused to be served on September 30, 2015, on counsel listed below by the CM/ECF system:

DENNIS DON BROWN
Brown Patent Law, PLLC
Suite 111E
2700 N. Hemlock Court
Broken Arrow, OK 74112
(918) 615-3357
dennis@dennisbrownpatents.com

JOHN CHRISTOPHER DAVIS
Johnson & Jones, PC
2200 Bank of America Center
15 West Sixth Street
Tulsa, OK 74119
(918) 584-6644
cdavis@johnson-jones.com

Dated: SEPTEMBER 30, 2015

/s/ Steffen N. Johnson
STEFFEN N. JOHNSON
Counsel for Appellant

CERTIFICATE OF COMPLIANCE WITH TYPE-VOLUME LIMITATION, TYPEFACE REQUIREMENTS, AND TYPE STYLE REQUIREMENTS

1. This brief complies with the type-volume limitation of Federal Rule of Appellate Procedure 32(a)(7)(B) because it contains 14,000 words, excluding the parts of the brief exempted by Federal Rule of Appellate Procedure 32(a)(7)(B)(iii) and Federal Circuit Rule 32(b).

2. This brief complies with the typeface requirements of Federal Rule of Appellate Procedure 32(a)(5) and the type style requirements of Federal Rule of Appellate Procedure 32(a)(6) because this brief has been prepared in 14-point Times New Roman, a proportionally spaced typeface, using Microsoft Word 2010.

Dated: SEPTEMBER 30, 2015

/s/ Steffen N. Johnson
STEFFEN N. JOHNSON
Counsel for Appellant